SURGERY OF THE HAND

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WOUNDS, INFECTIONS AND CLOSED TRAUMATA

A Book For
The Practitioner and The Surgeon

BY

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AUTHOR'S PREFACE TO THE ENGLISH EDITION

This book is the result of clinical experience research and lectures that have extended over a period of fifteen years I approached all therapeutic and technical problems and all suggestions—whether French or foreign—with an open mind put them through experimental tests and then adopted or rejected them according to the results obtained Readers can rest assured therefore that everything advocated here has at least passed the acid test of surgical application

The subject may be one that makes dull reading but it is certainly one that will repay careful study Those who will make the effort and apply the recommendations contained herein to their daily practice shall not be disappointed they will find out again and again that pathology stands out in relief as the foundation of treatment and that it serves as a sure guide in reaching such decisions as shall be considered necessary for the ultimate benefit of their patients

The translation of my book is indeed a pleasure to me The first edition published ten years ago was greatly influenced by Anglo-Saxon teachers at Johns Hopkins and McGill Universities which I visited in 1027 The great value of their work was thus made available and appreciated throughout France and now that it is my privilege to see my ideas and improvements in technique translated into English I take the opportunity of expressing to them my deepest gratitude for their teaching which has contributed so much to these advances

The unhappy time of its publication prompts me to express the hope that it will help our British colleagues who are in the services to spend profitably those long hours of waiting that characterise this war

M ISELIN

French Field Army
March 1940

accessible and/or to effect adequate drainage when the wound is already infected. Excision of wounds, including the removal of all foreign bodies and loose pieces of bone, has, on the other hand, only been made possible by the advent of anæsthesia and was only used as a routine procedure during the later stages of the war (1914-1918). Consequently *débridement* and excision are not synonymous terms: in time alone there is a difference of a century between the two.

For obvious reasons, we have used the revised version of the Basle Nomina Anatomica that was adopted by the Anatomical Society at Birmingham in 1933. The terms will be familiar to everyone, except perhaps flexor retinaculum, which now designates the anterior annular ligament.

T. M. J. d'OFFAY.

T. B. MOWAT.

hospital of Zurich from 1920 to 1930 wounds of the fingers accounted for the greatest mortality (17 deaths) and compound fractures of the femur took second place with 7 deaths

At the 7th International Congress of industrial accidents and diseases (Brussels 1935) Dr M Jaros of Prague read the statistics of the Central Bureau of Workers Accidents Insurance for Bohemia The long columns of figures furnish pitiless and precise evidence The statistics deal only with cases which were incapacitated for at least four weeks during the year 1929–1930 Out of a total of 40 216 injuries 3 263 cases (8 11 per cent) were wounds of the hand and 13 148 cases (32 69 per cent) were wounds of the fingers Consequently 40 8 per cent of all injuries were situated in the hand and the fingers and these cost approximately 30 per cent of the compensation paid for all the other cases (73 013 615 crowns against 244 502 804 crowns) [1]

These interesting statistics also give a comparison between infected and non infected cases 21 per cent of the total number of cases were infected The average cost of a non infected wound of the hand was 3 323 crowns and that of a septic wound 9 041 crowns A non infected wound of the finger cost 3 800 crowns and an infected one 6 803 crowns Non infected wounds of the right thumb cost an average of 3 530 crowns and there were no deaths infected wounds cost 5 872 crowns and there were *two deaths* Non infected wounds accounted for 3 deaths but they were cases of multiple injuries in addition to mutilation of both hands *Infected wounds accounted for 20 deaths and in 11 of these cases the wounds affected one finger only*

Now it is possible to avoid infection by an adequate treatment of the wound and this is where our efforts are particularly directed Figures from Czechoslovakia give us an idea of the end results Dr Albert who is in charge of the Bata shoe factory hospital at Zlin gives the following results for 1932 16 04 per cent of the cases turned septic (wounds of the hand in this industry account for 62 per cent of the total injuries) This figure has since been reduced to 8 8 per cent entirely as a result of the immediate and adequate treatment of wounds carried out either at the factory or at the hospital A pleasing feature is that Dr Albert has adopted the directions laid down in my previous book Mock and Böhler s figures (7 4 per cent

117 Crown = £1

PREFACE TO THE THIRD FRENCH EDITION

Two years ago, I glanced through a copy of the "Surgery of the Hand" borrowed from a circulating library used by students. The first two sections of the book, dealing with wounds and infections, were completely cut and marked; the third section, dealing with reparative surgery, had not even been cut. This unequal perusal of the book clearly showed that the surgery of the hand has the special feature of interesting two distinct classes of individuals. Wounds and infections are of interest to everyone: students, physicians and surgeons; while reparative surgery is only of interest to surgeons.

This is why the present edition is in two volumes. The first volume, "The Practitioner's Book," deals with wounds, infections and closed traumata of the hands and fingers. The second volume, "The Surgeon's Book," which is to be published shortly, will deal not only with reparative surgery but also with all congenital and acquired surgical lesions of the hand and fingers.

As the years go by, it is slowly being recognised that the treatment of lesions of the fingers is both difficult and of immense importance; but meantime, this view remains theoretical. The majority of whitlows are still incised in the middle line and cut flexor tendons are still sutured primarily, following the teaching of our ancestors and with all the drawbacks of their technique. Most of the wounds of the hand are either automatically stitched, or simply left open and dressed without exploration, and the results of this 'reflex' method of treatment, as Lecene used to call it, will be shown later.

And yet, on account of their frequency, these despised trivial lesions play a considerable part in industrial incapacities. My teacher P. Moure, Consulting Surgeon to the State railways, estimated that the comparative cost of wounds of the hand was 46 per cent. of the total sum paid as compensation for all injuries. My friend P. Mayer and Professor Clairmont have published statistics of all accidents treated at the teaching

on *reparative surgery* which had been disappointing until then but which I am pleased to say has been more successful since The great progress made will be dealt with in the second volume of this work

I wish to thank Dr Robert Monod for allowing me to work in his clinic at the Broussais La Charité hospital thereby permitting me to continue with him those difficult and interesting studies I also wish to express my indebtedness to Messrs Masson & Co for the confidence and friendship which they have always shown towards me

M ISELIN

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DARYL HART Infection of the Hand in Dean Lewis System f Surgery Prior ed Hagerstown Md

ALBERTO BARALDI Traitement les infection l la main (4th Congr argentin le chirurgie Buenos Ayres, 193)

infected cases) are similarly due to the immediate and adequate treatment of these wounds

The guiding principles of treatment are very simple every wound of the finger must receive treatment similar to that given to any wound of the extremities, all aseptic precautions must be taken, the patient must be anæsthetised, the lesions explored, contused tissues excised, loose fragments of bone removed, fractured ends of the bones trimmed and the wound must be stitched only if conditions are favourable for primary suture This, one might say, is all very elementary, common knowledge and beyond argument And yet the surgeons who put those principles into practice are only too few and far between, and it is a lamentable feature that if they are not misunderstood then they are so seldom put into practice

The reason is difficult to find Is it because young surgeons feel more interested in abdominal surgery? Is it because experienced surgeons are reluctant to make the effort to keep abreast with a branch of surgery which is considered, and rightly so as minor? We will devote a new chapter to the study of the social and professional aspects of the surgery of the hand

The views expressed in the 1933 edition have stood the test of time The chapters on infections are very little altered except that certain points have been emphasised Certain additions have been made *Acute Spreading Infections*, *Erysipeloid Infections*, of which certain cases met with have made me realise the necessity for a description

The study of wounds has been more altered, and the chapter on *Compound Fractures of the Fingers* has received particular attention It has been extended and recast mainly as the result of Bohler's report to the Brussels Congress in 1935 I have also recast the chapter on the prevention of tetanus, as the result of the work of L Bazy on *Anti-tetanic Vaccination* Finally the important studies of Leriche and Fontaine on *trophic and painful sequelæ* have necessitated the addition of a new chapter of the greatest practical interest The reports given at the Brussels Congress are absolute mines of information and of original work I have drawn considerably from these as well as from the work of David Hart and the report of Baraldi to the Congress of Argentine surgeons

In short since the 1933 edition I have had little to alter on wounds and infections All my efforts have been concentrated

PART III—CLOSED TRAUMATA OF THE HANDS AND FINGERS

PART IV—ASSESSMENT OF INCAPACITY

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SURGERY OF THE HAND

PART ONE

WOUNDS

INTRODUCTION

Originally the object of this work was to point out the dangers of ill-considered primary suture of wounds of the hand and finger dangers which vary in severity some serious others less so

Here are the records of serious complications following upon suture of wounds which I was able to collect for my first book

CASE 1 A woman aged 27 sustains a deep and contused wound of the left thenar eminence as a result of a motor accident She has in addition a fracture of the shaft of the right humerus The wound is carefully cleaned with ether and a *single clip* is inserted to close the undermined skin edges

Two days later there is marked swelling The clip is removed but the infection spreads The radial bursa becomes infected it is opened The wrist joint becomes infected it is immobilised The patient s general condition deteriorates A metastatic abscess appears at the site of the fracture of the humerus it is incised

After a stay of four months in hospital the patient markedly emaciated is discharged with a healed but useless left hand and with a chronic discharging osteomyelitis of the right humerus

CASE 2 A woman aged 80 sees a piece of glass falling down on to her while she is walking along the street She instinctively protects her head with her right hand The skin of the dorsum of the hand is simply cut and the tendons are intact A doctor sees her ten minutes later and being faced with a clean and recent wound cleans it carefully with ether and iodine and puts in three clips

The wound first gives way and eight days later there is an abscess on the dorsum of the hand this is incised but it spreads towards the webs of the fingers and from there to the palm Multiple incisions are made The patient is left with a stiff and painful hand and the middle finger being ankylosed in the extended position has to be disarticulated

The case record does not say whether or not the skin edges were sutured after the amputation the fact remains however, that twenty four days after the second operation the radial bursa becomes infected and has to be incised

On May 27th, 1920 a 10 cm incision is made above the wrist and the flexor retinaculum is incised The common flexor sheath is found to be full of pus and is drained

CASE 6 A wound of the little finger is trimmed and sutured on the first day Three days later it gives way and there is an abscess of the tendon sheath Fortunately there is no communication between this tendon sheath and the ulnar bursa but the infection spreads to the deep palmar spaces and gives rise to great anxiety for some days Small incisions adequately drain the pus and the patient escapes with a stiff and useless little finger

These occurrences might lead one to believe that if primary suture were not performed there would be no complications The following case records absolutely disprove this contention

CASE 7 A man wounds the base of his left thumb with a small steel tube on May 9th 1930 He is treated at the ambulance room of the factory and then sent to a nursing home on May 27th His wound is treated with moist dressings and he is discharged on June 3rd

He is re-admitted on June 7th because the wound is suppurating more than ever An incision is made and propidon is given on the same day The temperature remaining at 102·0 F a second incision is performed on June 11th and two drains are inserted into the palm The general condition is poor

The drains are removed on June 17th Serious hæmorrhages occur on June 19th 21st and 24th the temperature rises but comes down to 99·6 F on June 30th and remains at that level for a short time The hand looks better Hæmorrhages recur on July 8th 9th and 10th There is severe pain temperature rises to 103 2 F the general condition is poor the hand is swollen and the wrist is painful.

I am called in urgently on account of another hæmorrhage An amputation is performed on account of the poor general condition and of a suppurating arthritis of the wrist On the following day the temperature is 103 F and then falls to 99 F on July 19th The patient is cured six weeks later

CASE 8 D sustains a crush of the terminal phalanx of the middle finger in a machine on December 30th 1927 No intervention is carried out and he is advised to soak his hand in warm lotions.

CASE 3 A policeman is bitten on the dorsal surface of the base of a finger of the right hand while effecting an arrest The wound, 2 cm in length is washed with tincture of iodine and *immediately closed with a clip*

I see him two days later, his facies is anxious, he is markedly anæmic, and the hand is markedly swollen, particularly on the dorsum in the region of the wound The clip had been removed the day before, and had been in place for twelve hours only

Débridement of the wound is carried out and is followed, on the next day, by opening and drainage of the joint cavity (Dr Moure), but the infection spreads and invades the palm, which becomes painful and swollen, there is also marked swelling of the dorsum of the hand

Four days later (Iselin), the finger is disarticulated and the head of the corresponding metacarpal removed in order to establish proper drainage This leaves an open wound, in which one clearly distinguishes pus oozing from underneath the tendons and from the dorsum of the hand

It takes two months for healing to occur The patient has lost 15 kgm in weight, his hand shows paralysis of the interosseous muscles, but, being very active, he makes rapid progress

CASE 4 A butcher, aged 29, is wounded by a pole-axe on September 11th, 1925 The wound is situated on the anterior aspect of the wrist joint immediately proximal to the distal crease He attends the Hôtel-Dieu the same night, and a resident stitches the wound On September 13th there are violent pains, the fingers are semi-flexed, and there is a rise of temperature, all the signs of an abscess of the bursæ

My friend, Dr Senèque, makes a long incision and opens the ulnar bursa from end to end on the same day Progress is satisfactory, and the infection dies down An examination on November 1st, 1925, shows movement of all the fingers except the fifth, the ring finger is weak, and the scar is slightly adherent to the tendons

CASE 5 (Dr Lenormant's clinic) A young Italian is wounded on April 10th, 1920 There is a superficial wound of the palm with intact tendons, and a dorsal wound with bruising and undermining of the edges as far as the finger joints, but without bony lesions The thumb is intact The wounds are cleaned, hæmostasis is secured and the skin edges are stitched with silkworm gut Drainage of the palm is provided by rubber tubing and of the dorsum by strands of S W G

During the following days the wounds give way, and infection and gangrene of the fingers occur On May 4th, 1920, twenty-four days after the injury, the gangrenous parts of the four medial fingers have to be amputated

On December 20th the wound is explored again the tendon sheaths are bare but are not infected

Progress appears to be satisfactory until the end of January when pain and suppuration re-appear

On January 27th amputation of the little finger

On January 28th severe pain and œdema of the whole hand articular pain at the wrist

On January 29th operation (Iselin) Amputation of the fifth metacarpal bone and of the ring finger with its metacarpal open dressing

During the following days the temperature falls from 100·0° to 98·6° F in three days The œdema on the dorsum of the hand and forearm persists and it is obvious that there is an arthritis of the wrist On February 8th the wound being almost healed the hand is immobilised in plaster

On March 25th the patient is seen again The wrist joint is ankylosed the fingers are swollen and have very little movement It is difficult to foresee any improvement before a month but meantime the hand is useless

We take from Bérard and Lumiere s article the following case in which similar lesions lead to a fatal issue as the result of tetanus

CASE 10 Ar aged 21 labourer is wounded on July 29th 1919 The terminal phalanx of the left ring finger is crushed there is a subungual hæmatoma and a wound of the lateral aspect of the terminal phalanx near the edge of the nail The practitioner who sees the patient simply paints the wound with tincture of iodine and applies a dry dressing No preventive injection of serum is given

On August 0th the first symptoms of tetanus appear after an *incubation period of six days It is only forty-eight hours later that* the patient is taken to the Hôtel Dieu Hospital in a grave condition with trismus profuse perspiration contracture of the abdominal muscles and violent spasmodic fits succeeding one another at intervals of a few minutes

The wound of the ring finger has not been disinfected yet It is livid and fœtid *the terminal phalanx is fractured into numerous little fragments* and the nail is beginning to detach itself spontaneously We perform an immediate amputation under local anæsthesia and administer a large dose of anti tetanic serum and sodium persulphate intravenously the latter puts an end to the fits

These procedures fail to stop the progress of the toxæmia and six days later on August 13th the patient dies without spasms but in severe hyperpyrexia which invariably marks the end of the toxæmia

The terminal end of the finger is amputated in hospital, and the *wound is left open*

One month later, and after apparent cicatrisation, a whitlow bursts open and the tendon sloughs out In April, the suppuration is still present and has a fœtid odour

At the end of May, a median incision is made into the palm, and the flexor retinaculum is sectioned

On May 24th, he comes to hospital on account of a secondary hæmorrhage during the previous night, he looks very pale and extremely ill

The hand shows the following features The palmar aspect—a long median incision, the tendons are bare and gangrenous, behind them, there is a lake of fœtid and grey pus, which had spread from the hypothenar space (a small inadequate incision had been made on the hypothenar eminence) The dorsal aspect—a fluctuating abscess at the level of the wrist joint, the wrist joint itself is very painful The temperature is 104° F

Operation by Professor Lecène on May 27th The latero-ulnar incision of Morestin is made, the first row of carpal bones is curetted, a radial counter-incision is made and a transverse drain inserted The hypothenar eminence is also counter-incised, and drainage established there too The hand is maintained in the position of function by a dorsal metal splint

For two days there seems a little improvement, and two injections of propidon are given On the third day, however, the hand becomes cyanosed, and the patient stuperose

On May 30th, under general anæsthesia (ethyl chloride), a circular amputation is performed at the level of the upper third of the forearm with *débridement* of the lateral aspects (Iselin)

Examination of the amputated portion There is a collection of pus in the hypothenar space, the thenar space is free There are pieces of bone left in the wrist joint The dorsal subcutaneous space is full of yellow pus, and there is foul œdematous pus tracking along the ulnar vessels

Case 9 M B   , aged 67, is involved in a motor car accident on December 20th The hand is caught under the car

A dressing is applied to the wound immediately after the accident The patient is removed to hospital, where the wound is cleaned without an anæsthetic, and is treated with Dakin's fluid by the continuous drip method, anti-tetanic serum is given On December 21st, the temperature is 100 7° F, and normal on the succeeding days Little œdema, pain decreasing A radiograph shows comminuted fractures of all the phalanges of the third, fourth and fifth fingers of the left hand

On December 26th the wound is explored again the tendon sheaths are bare but are not infected

Progress appears to be satisfactory until the end of January, when pain and suppuration re appear

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On August 6th the first symptoms of tetanus appear after an incubation period of six days It is only forty-eight hours later that the patient is taken to the Hôtel Dieu Hospital in a grave condition with trismus profuse perspiration contracture of the abdominal muscles and violent spasmodic fits succeeding one another at intervals of a few minutes

The wound of the ring finger has not been disinfected yet It is livid and fœtid *the terminal phalanx is fractured into numerous little fragments* and the nail is beginning to detach itself spontaneously We perform an immediate amputation under local anæsthesia and administer a large dose of anti tetanic serum and sodium persulphate intravenously the latter puts an end to the fits

These procedures fail to stop the progress of the toxæmia and six days later on August 13th the patient dies without spasms but in severe hyperpyrexia which invariably marks the end of the toxæmia

CASE 11 A man, aged 62, has his thumb crushed by a stone A subungual hæmatoma results, and a dressing is applied to it He attends the Broussais Hospital eight days later There is suppuration of the finger and of the radial bursa An operation is immediately performed, it demonstrates a comminuted fracture of the terminal phalanx, the fragments of which are bathed in pus The bursa is opened in the usual way The patient is a diabetic and shows no improvement in spite of the administration of insulin His general condition deteriorates to such an extent that an amputation of the forearm has to be performed He appears to improve after that, but dies in diabetic coma twenty days after the amputation

One finds the same initial mistake in all these impressive cases a deep lesion, very often a fracture, has been missed, débridement[1] *of the wound has not been done, and the gravest type of infection has found a favourable terrain to develop Now, experience has taught us the great frequency with which bony lesions go undetected In our* 110 *cases, a fracture was present in* 103 (86 *per cent*), fractures that can co-exist with insignificant external lesions, as is borne out in the following illustrative cases and figures

CASE 12 Fig 1 concerns a young man whose hand had been crushed by a stone The index finger, being badly injured, had been

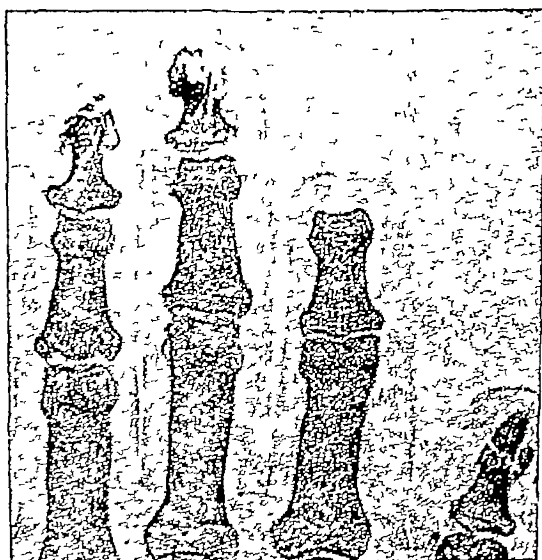


Fig 1 Unrecognised fractures of the terminal phalanges of the thumb, middle and ring fingers At the index finger, a complete fracture of the terminal phalanx had been detected and treated by disarticulation

[1] See Translators' preface

treated with particular care an exploration had been performed under local anaesthesia and the completely smashed terminal phalanx had been disarticulated The other fingers being comparatively little affected had simply been dressed A radiograph taken on the next day showed comminuted fractures of the thumb second and third fingers

These minute bony fragments are responsible for many complications fatal tetanus which is fortunately very rare severe infections such as we have already mentioned but more often they foster suppuration for weeks or months and prevent the healing of a wound that would have healed in fifteen days if it had been properly treated at the outset Further they may give rise to pain after healing of the wound and union of the fracture the following case is a good example of this

CASE 13 M Rix is wounded in September 1929 His thumb is crushed and presents a small insignificant wound which is

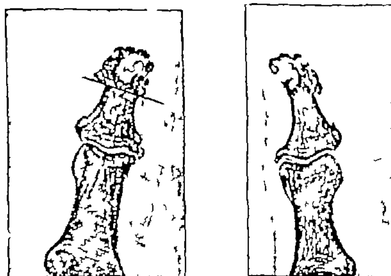


Fig Unrecognised fracture of the terminal phalanx.

not treated Following a temporary period of incapacity he finds it impossible to start work on account of violent pains in the thumb and he is referred by the insurance company to a doctor who treats him for about six months He is referred to us on May 10th

A radiograph shows a *fracture of the distal end of the terminal phalanx of the right thumb* (Fig 2)

A curved incision is made under local anaesthesia and the distal

half of the terminal phalanx is removed, as a few drops of pus are found in the bone, the wound is drained and left open

Lastly neglected wounds, particularly those at the base of the fingers and hand, can be the origin of an uncommon but serious complication that, we believe, we were the first to describe a neighbouring arthritis (l'arthrite de voisinage) We have seen three cases, two at the wrist and one at the elbow Case 14 was shown to Mr Lecène on several occasions

CASE 14 Pop Albert, aged 18 *Arthritis of the wrist following upon a small wound of the thenar eminence* He is wounded on June 21st, 1929 by a splinter of wood, which enters the left thenar eminence near the web A mild infection develops and persists for more than eight days after the removal of the splinter, later there is sinus formation The wrist becomes painful four or five days later, but he carries on with his work for two months, treating himself with baths and fomentations during that time

On August 26th, he comes to Saint-Louis Hospital for advice, there is a small suppurating wound, from which one extracts a small piece of wood during the course of an exploration under local anæsthesia The wrist is swollen, the skin is shiny and slightly œdematous, the movements of the wrist are very limited, particularly in extension, and palpation reveals tenderness and thickening of the joint There is a large supratrochlear gland The patient gives a history of urethritis at the age of 20, but there is no discharge at present, and there are no gonococci in the prostatic secretion A provisional diagnosis of tuberculous arthritis is made, and the supratrochlear gland is removed for histological examination The wrist is immobilised in plaster

The *histological sections of the gland* show ordinary inflammatory changes and no tubercle bacilli On October 9th, the joint is still red and swollen, and is now completely stiff We ask Mr Lecène to see the patient, and he advises immobilisation in plaster after verifying the histological findings

On December 15th, the plaster has been renewed twice, and, when the second cast is removed, the wrist joint is painless and the movements of the fingers have returned although still a little limited

On January 21st, the movements of the fingers are normal The wrist joint has a normal temperature, and movements are possible although somewhat limited

On February 29th, the wrist is swollen and a little warm, there is stiffness and marked limitation of extension, the lesion of the wrist is therefore considered cured

CASE 15 Jou André aged 10 *Arthritis of the elbow following upon a small wound of the fingers*

On January 15th 1930 the patient a lift boy has the index and middle fingers of his left hand trapped in a door Superficial wounds on the dorsal aspects of the corresponding terminal phalanges

On January 25th 1930 the wounds are almost healed but signs of arthritis of the elbow have appeared during the last two days pain and limitation of movements the elbow is slightly swollen and warm and there is no tenderness of the bones *A large supratrochlear gland* is removed and submitted for histological and bacteriological examinations The elbow is immobilised in plaster on the same day

On March 8th 1930 the plaster is removed there is no sign of arthritis *The histological examination* shows the ordinary inflammatory changes and no tubercle follicles or bacilli The patient is seen again on April 2nd the elbow looks normal and the movements are free

CASE 16 Mar Julio aged 31 *Arthritis of the wrist following upon a small wound of the index finger*

On March 20th 1931 the patient is wounded by a box falling on him there is a small superficial wound on the dorsal aspect of the proximal phalanx of the right index finger It is left open and dressed it suppurates slightly during the succeeding days

On April 3rd the wound being healed violent pains start in the right wrist The wrist is swollen and hot the skin is redder than normal the movements are very limited and there is a maximum point of tenderness in the middle of the dorsal aspect of the carpus There is a swollen supratrochlear gland but no swelling of the axillary glands The patient shows no signs of gonorrhœa and gives no previous history of it As a result of the experience gained from the two previous cases we simply immobilise the joint in a plaster cast

On April 18th the plaster is removed the wrist looks normal its movements are free and the enlarged lymph gland is smaller but still palpable

COMMENTARY

Every one of these striking cases shows that a trifling lesion wrongly considered as insignificant can lead to the most serious complications *on account of a mistake in treatment*

The mistaken treatment in many of these cases was the performance of primary suture Is one to conclude that this line of treatment must never be adopted in wounds of the hands and that one must never suture wounds not made by

the surgeon"? No, for this purely negative attitude is both insufficient and unwarrantable.

It is insufficient because as is shown by many of our cases, when suture had not been done (the wounds having been simply left open and dressed, because they were apparently trivial lesions) complications had followed. It is obvious, therefore, that it is not sufficient to leave the wounds open in order to escape complications.

It is unwarrantable because it is purely negative. It is obviously essential to tell people what they must do, but it is more important still to show them first what must be done: *treat the wounds*.

The experience gained during the war (1914-1918) has taught us that the practice of treating wounds without exploration was disastrous; peace-time surgery is no less enlightening. Everyone agrees that, when faced with an open wound of the arm or leg, one must explore the wound, discover the damage, and excise all contused tissues because they form a very favourable nidus for the growth of micro-organisms; then, in suitable cases and *only after this preliminary treatment*, carry out primary suture of the wound.

Every wound of the fingers and hand must be treated according to these well-recognised principles. *There is no reason why this should not be done*, for it has been shown what happens otherwise. On the other hand, a wound that is properly treated heals in a few days and hardly ever suppurates, because the hands of workmen, and particularly those soiled with grease, appear to harbour only attenuated organisms. In support of this, we now give some results obtained by the house surgeons of the Saint-Louis Hospital in 1930. *Out of 110 wounds treated, only one suppurated, and that was the result of mistaken treatment.*

It was a case of subungual hæmatoma of the thumb that had been operated on by a newly appointed house surgeon who was not yet fully conversant with our methods. After excising the wound he inserted two skin sutures. The following day the sutures were removed, but infection was already present, and it spread to the terminal joint of the finger. A resection had to be performed followed by immobilisation in plaster for one month.

All the other cases healed in one to four weeks according to the extent of the lesions, and *there was complete absence of pain*, for which the patients were full of gratitude. On the

other hand a week never passed without the arrival of an infected case that had been treated by practitioners or sometimes in other hospitals and *the majority of these cases had been sutured without an anæsthetic* This is the grossest mistake and accounts for the bad results obtained in wounds of the fingers for a proper exploration of the wound is impossible without perfect anæsthesia

In order to carry out this treatment satisfactorily, it is essential to have some surgical knowledge adequate materials and time

The surgical knowledge necessary is small Every student knows how to wash his hands to disinfect the skin to place towels to use artery forceps and to tie a knot For certain special cases, all the necessary details will be found in this book but an attempt must be made to read them remember them and apply them It is a type of surgery that requires care and attention I have often seen it more satisfactorily performed by students and residents who were really interested (because these were the only operations allowed to them) than by brilliant residents who were more anxious to do gastrectomies

Certain implements are required needles and a syringe for local anæsthesia towels and swabs sterile gloves and instruments in good working order It is also more than essential to have an assistant and finally plenty of time for these operations take a long time

I can easily imagine how certain routine-minded doctors will be horrified when they read these words Is one to ask practitioners to buy surgical instruments to put on gloves to possess sterile swabs and towels and the last straw to find an assistant ? But for my part I shudder to think that a practitioner who is without any surgical experience will operate upon the hand of a breadwinner on the corner of his table where littered drug samples have to be pushed aside without anæsthesia with poor instruments with towels and swabs of questionable sterility while he makes all the possible aseptic mistakes because he has no help then when complications occur he rids himself of the patient by sending him to a surgeon One of the essential objectives of my books has been to teach doctors to respect lesions of the hand and to give those who already have that respect the necessary directions in order that they might avoid making mistakes and so perform useful work

It cannot be too strongly emphasised that the treatment of wounds of the hand is essentially surgical One can pile upon one finger all the best chemical and biological products, and the latest drugs, they will only lead to disappointment if there are present in the wounds such things as foreign bodies, small bony fragments fractures and contused skin edges Böhler very aptly puts it "Laboratory studies on micro-organisms, agglutination of anti-bodies, immunity, the physical and chemical equilibrium of wounds acidosis and osmosis are all very interesting, but they ought not to make one forget the nature of a wound and the necessity for surgical treatment"

We are almost ashamed to have dwelt so ponderously on such patent facts, but experience teaches us that they are not generally appreciated *Every patient with a wound of the hand must be fully anæsthetised and his wound systematically explored*

CHAPTER I

GENERAL THERAPEUTICS

Anæsthesia

Novocaine injected in a "ring"—completely round the finger—is the method of choice. It is nearly always possible to use this method even if several fingers are wounded (two or three in our cases). We have never observed the slightest difficulty. It is only contra indicated in cases where the lesions extend to the base of the fingers which prevents the application of a tourniquet. A precise technique must be followed if satisfactory anæsthesia is to be obtained.

Technique of "Ring" Anæsthesia. *A tourniquet is first* applied around the base of the finger (a small rubber tube or a thin strip of sheet rubber is used). This gives a bloodless field and prevents the diffusion of the anæsthetic solution towards the palm. Never start the injection by pricking the lateral surfaces and more particularly the palmar surface because these are extremely sensitive. The skin of the dorsum of the finger is much less sensitive and it is the site where the needle is first introduced; the needle is then directed to both lateral aspects of the finger. When these have been rendered insensitive the needle is withdrawn and reintroduced into the skin of the lateral surface; it is then pushed towards the palmar surface. Five to 10 c.c. of novocaine is sufficient for a good anæsthesia. We have always used the 1 per cent strength without adrenaline; the absence of the latter eliminates all possibility of gangrene. This important detail has been stressed by Moure at the *Société de Chirurgie*. Lastly *one must wait for ten minutes before starting the operation*. If these precautions are carefully observed a perfect anæsthesia will always be obtained.

General Anæsthesia. When the lesions are extensive towards the hand a general anæsthetic must be given. In 1930 we had occasion to use it twice only in 110 cases of wounds of the fingers. It is regularly used in lesions of the hand except those of the dorsal surface. As the operation is usually a long one (half an hour is a fair average for complex lesions) we usually employ ether or chloroform. Anæsthetics

such as ethyl chloride and evipan are insufficient on account of their short duration

Systematic Exploration

Every operation must be carried out with the greatest care It is essential to have a table covered with a sterile towel on which to rest the hand, which is already painted with iodine and protected with sterile towels The operator must put on gloves, and sit down, for the operation is a long one. In other words, one must take exactly the same care as one would take for a case of appendicitis or hernia

Débridement of the wound is performed through incisions so placed that there is no danger of wounding the tendons or important blood vessels (I know of a case in which the flexor tendon was cut in this fashion) A search is now made for deep-seated lesions, the frequency of which has already been pointed out, particularly bony, tendinous and vascular lesions The treatment of these lesions varies according to their nature, and will be discussed individually in the next chapter, but the *treatment of the soft parts is essentially the same in all cases*

Treatment of the Soft Parts

It is essential to excise all contused tissues, for, as the study of war wounds clearly showed, *during a few hours*, it is these parts only that are infected, while the surrounding healthy parts are practically aseptic The contused tissues are also destined to become *gangrenous* and to be eventually eliminated by the only process known to the tissues, that is suppuration Everything that is not going to live must be removed, and this applies particularly to the skin The skin is poorly vascularised, and the edges of skin flaps with narrow pedicles are absolutely fated to become gangrenous It is obvious, therefore, that the edges of the wound must be excised and trimmed, and that the flaps must be shortened and rounded Thanks to these precautions, *suppuration can be avoided* even without closure of the wound, provided the subsequent dressings do not infect it In the case of the hand and fingers, it is most important, for functional reasons, that there should be no suppuration It is known that movements of the fingers depend not only on the freedom of the joints and tendons, but also on the suppleness of the skin and subcutaneous tissues Everyone has seen immobility of fingers that are otherwise normal brought about by a simple cicatrix, which prevents the skin from

moving on the underlying bone This is why suppuration of the hand is particularly disastrous It originates in a small wound invades the surrounding subcutaneous tissues and excluding the more serious complications when healing occurs it leaves a thickened indurated and adherent area which needs massage baths and mobilisation for many weeks before the fingers can regain their normal function

Let us take as an example a wound of the base of the index finger It is sutured redness appears on the second day suppuration on the fourth and it bursts open on the sixth or seventh The wound is now much larger than the original one and it will take three or four weeks to heal It will also be subject to the occurrence of inflammatory and cutaneous sclerosis just mentioned On the other hand a wound properly treated and left open will heal in ten to twenty days depending on its size It will leave a perfect linear scar surrounded by normal tissues and will not have exposed the patient to the possibility of dangerous complications

The primary suture of wounds of the hand and fingers must therefore be reserved for the ideal cases When it is performed under good conditions it results in rapid and perfect healing but when it fails it is as already seen the cause of complications and of delay in healing Primary suture will unfortunately be the exception the rule being open treatment after excision of the contused tissues and hæmostasis Actually we have at the Saint Louis Hospital performed primary suture in 42 out of 110 cases but always under the same conditions that is the wound was never more than four hours old, the skin was well vascularised and there was enough of it to allow ***suture without tension*** after adequate excision. Not the slightest complication occurred in any of these 42 cases Infected wounds that we saw and that had been treated elsewhere had all been sutured with disregard of the two rules just mentioned in one case suture had been done *three days after the receipt of the injury* In comparison with a few that had been properly explored excised and stitched the majority showed sutures under great tension and when these were removed a bony fragment literally shot out Others had had flap amputations performed, and the flaps had become partly gangrenous because they were too narrow at their bases and too large at their extremities

We believe therefore that we are justified in drawing the

following conclusions, for which there is so much evidence that they appear to be beyond any argument

Suture is to be performed *only in recent wounds (six hours maximum), and this is to be done only after careful preparation and on condition that the skin edges can be brought together without tension*

Technique of Excision

Excision requires a most careful technique It must be adequate, that is, one must cut through healthy tissue, but, at the same time, it must not be carried out so far as to lead to useless loss of substance, which would make suture impossible An excision of 3 or 4 mm is, on an average, sufficient to eliminate all contused tissues

Large instruments are useless for this purpose, the dissecting forceps in common use have a bite of about 3 or 4 mm and, with the added space necessary for the scissors, they lead to a loss of substance that is never less than 5 mm Kocher's artery forceps are also incapable of catching an isolated small vessel, they grasp large pedicles, which need thick catgut to secure them with, and which must be eliminated as sloughs

We advise, therefore, the use of fine instruments for these operations[1] Small dissecting forceps, small curved and

[1] The essential requirements of those who are going to undertake the surgery of the hand —

Anæsthesia—
- Metal syringes
- Bayonet needles fine 7/10, long and fine 6 8/10
- A small rubber tube for a tourniquet
- Novocaine, 1 per cent, without adrenaline

Instruments—
- A pair of ophthalmic scissors (12 cm and curved)
- One dissecting forceps (three teeth and 12 cm)
- Two Chaput's forceps for the skin edges
- Three Terrier's forceps (9 cm)
- Two forceps for sterile towels
- Bland Sutton's needle (6 cm) Do not use Reverdin's needle, it is too expensive to buy and to repair
- Silkworm gut and metal wires in preference to linen thread or silk
- Catgut 00

Dressings—
- A bed or table for the patient to lie on never operate on a patient who is sitting up
- A small table of the same height on which to rest the hand
- A sandbag covered with some impermeable material to fix the hand
- One towel (40 × 40) to put on the table
- One towel (40 × 40) with a hole
- Small swabs (5 × 5)

Gloves—
- Strong Chaput's gloves

blunt-ended scissors Halsted's small artery forceps without teeth small retractors with teeth We have had made, by *Colin et Cie* a box containing those instruments The same applies to the needles the small intestinal needle of Reverdin which is generally used is fragile expensive and makes big holes the skin of the fingers is fragile and cuts easily It is easier and more economical to use the fine triangular needles of Lane threaded with fine silkworm gut Silkworm gut is better than silk as it is in my experience less liable to infection

Hæmostasis must be carefully and thoroughly done The bleeding vessel must be secured without the inclusion of any surrounding tissue and must be tied with 00 catgut The small size of the artery forceps and the fineness of the catgut exclude the possibility of catching and tying large pedicles It must not be forgotten here that all ligated tissues eventually slough

If for some reason or another it is impossible to catch the bleeding point only *it is better not to secure hæmostasis* as advised by Böhler a well placed dressing covered with layers of absorbent and non absorbent cotton wool secured in place by a crape bandage will stop all hæmorrhage

The Use of Skin Grafts in Recent Wounds

When the excised edges of the wound cannot be brought together without tension and when the conditions governing primary suture are satisfied one must proceed to skin grafting It is one of the most satisfactory procedures that I have employed during recent years

Generally speaking there are two types of cases the usual case is that in which the skin loss is small the rarer type of case is one in which there is great loss of skin and I have only met with this latter type in cases where there had been loss of the thumb and the index finger

When there is considerable loss of skin when the bones muscles and tendons are bare a thick and very vascular graft is indicated only a pedicle graft meets the case (*v* Fig 9 p 33)

When there is only moderate loss of skin usually linear a thin and free graft suffices I have consistently had very satisfactory results with grafts held in place by dental wax moulds The technique is simple and is now outlined

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- Small swabs (5 × 5)

Gloves—
- Strong Chaput's gloves

phalangeal joints but Kanavel (who advocates it for infections only) has been responsible for popularising its use and determining the position of the thumb, which is of fundamental



Fig. 4 Useless thumb on account of its fixed adducted position caused by the scar of a simple cutaneous wound

The wound was on the dorsal surface the thumb was in a forward and ulnar position, which was perfect. It was pulled backwards by two sutures and fixed there in a dressing *It is now useless, the patient being able to grasp* only between its internal border and the base of the index finger

importance A thumb fixed against the palm is useless because *it cannot be brought in opposition with the other* fingers Fig 4 shows a thumb fixed to the second metacarpal by a retractile scar

Numerous observations will be given later and in particular

Technique of Skin Grafting with Dental Wax Mould (Outlay)

The wax is softened in a water bath An accurate impression of the region to be grafted and its surroundings is then taken in order that the mould might be stable when it is finally in place A thin slice of skin is cut with a razor and placed on the raw area, or on the under-surface of the mould, whichever is more convenient The mould is then kept in place by a dressing and is not disturbed until the fifth day, when the graft has taken The mould is then removed, and the wound is dressed with *tulle gras* These grafts usually take by first intention, and some instances of this will be given later in this book (*v* Fig 10, p 33)

Position of Function

In any wound where the possibility of ankylosis is at all likely, one must, at the outset, put the fingers in the position of maximum usefulness, for, like the knee and the hip, the hand and the fingers also have an optimum position This

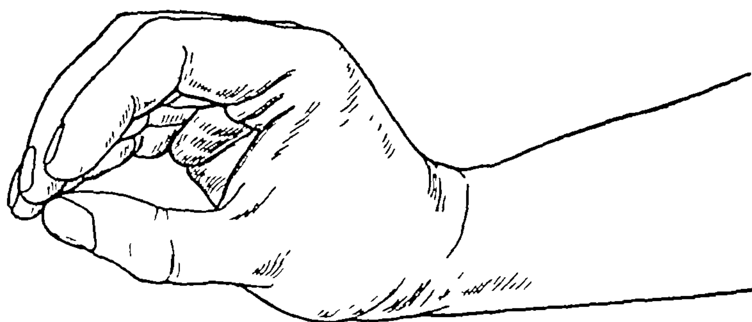


Fig 3 [The position of function wrist slightly dorsiflexed, fingers semi-flexed and the thumb in opposition

position has been described by Kanavel as "position of function," that is to say, a position in which the smallest movement of the ankylosed fingers will be useful This position is defined thus (*v* Fig 3) —

Wrist in 60 degrees dorsiflexion

All the finger joints in 60 degrees flexion

The thumb separated from the palm, in abduction and opposition, the second phalanx being slightly flexed

The value of this position had already been shown by Ollier in cases of resections of the wrist joint, and he had laid special stress on the necessity of flexing the metacarpo-

The Struggle Against Tetanus

Tetanus is a comparatively frequent complication of wounds of the hand (1 in 2 957 Fredet) At the *Société d Anæsthésie* meeting in 1936 a short debate on the treatment of tetanus by serotherapy and avertin brought out that out of 5 cases reported 3 cases were due to wounds of the hand (Desmarets and Gover (1) left hand Thalheimer right middle finger R Monod pricked finger) Berard has reported six cases of tetanus following upon what he calls subungual hæmatoma (r p 38)

Tetanus is sometimes a complication of small lesions, and one is easily tempted to give preventive injections of anti tetanic serum systematically to all injured persons but this treatment is not without harm We now possess anatoxin (toxoid antitoxin) which allows us to give immunity without danger but unfortunately this immunity is not immediate and here resides the problem of the medical prevention of tetanus

Antitetanic Serotherapy

The administration of A T.S is not without danger There *are cases of sudden death in addition to the usual anaphylactic* complications which are occasionally encountered in patients who have had previous doses of serum Hardouin (2) of Rennes speaking at the *Société de Chirurgie* meeting gave details of a fatal issue in a woman, aged thirty There was a small wound of the wrist and there had been some hesitation whether or not to give serum but as it was during the period when a practitioner of the North had been condemned because he had been found guilty of not giving A T.S to a patient who had sustained a contused wound of the hand and had died of tetanus two days later *One had to be prudent* (Hardouin) It was therefore decided to give 2 5 c c of serum and the patient died in convulsions five minutes later

The author has found 15 similar cases in the French literature alone Mackenzie and Hanger (3) estimate that there is one fatality for every 56 000 injections and Pfaundler records 3 *cases of sudden death in* 110 000 *injections*

Despite the undeniable facts that were reported the communication of Hardouin was badly received at the *Société de Chirurgie* and the written report of the meeting gives a very vague idea of the violence of criticism to which he was

on p 86, showing the possibility of a perfect functional result with an ankylosis in good position.

I have seen a patient with a stump of his index finger that is constituted by the proximal phalanx only. It is mobile in a 30-degree arc, but this relative ankylosis is not in sufficient flexion, because, in grasping, it is not used and does not come in alignment with the other fingers It also gets in the way, because it is in half-extension, and it is quite obvious that, had it been in a greater degree of flexion, it would have been a useful finger rather than a handicap

In order to attain this position of function in a dressing, it is most essential to *forbid the use of the evil straight wooden finger-splint*, which tends to cause a series of ankylosis in extension

Immobilisation

Böhler insists, and with reason, on the immobilisation of the wounded hand and fingers, (for instance, all my skin grafts have taken since I started immobilising them with dental wax moulds)

If the wound affects the hand or several fingers, a wire mesh splint, bent twice and lined with cotton wool, is an excellent form of immobilisation

If the lesion affects one finger, a small thin metal splint of 10/10 thickness, which is bent and accurately moulded, is used The necessity of immobilisation necessarily leads to infrequent changes of the dressings (p 119)

If the fingers only are wounded, a roll of cotton wool is placed in the palm of the hand, the fingers are arranged on one side of this and the thumb on the other, the dorsal surfaces of the fingers are then covered with cotton wool, and bandages are applied in order to maintain a *closed hand*

When the wounds are situated at the extremities of the finger, there is, naturally, no need to maintain the position of function, as ankylosis is not to be expected On the other hand, when the wounds are situated on the sides or the base, and even if only one finger is affected, the other remaining fingers must be included in the bandage, and the thumb is left free It is a wise precaution to place some cotton wool between the fingers to prevent maceration of the skin When the thumb is also wounded, it must then be included in the dressing

who suffered from a paraplegia after an injection of serum and who sued the practitioner who treated her

Antitetanic Vaccination

Credit must be given to H Vallee and Louis Bazy (6) for the first trials of satisfactory antitetanic vaccination in man They reported their trials to the *Académie des Sciences* and to the *Société de Chirurgie* in June 1917 But vaccination has only been of practical value since the discovery of anatoxin (toxoid antitoxin) by Ramon

Vaccinal immunity is *active* in comparison with that of serum which is *passive* but the former has a delayed action while the latter acts immediately on the other hand the former persists for several years (five years according to Ramon and Zoeller)

The injection is without drawbacks a single one is necessary and it can be combined with diphtheria anatoxin and or with T.A B vaccine It is lasting and years later it is only necessary to give another injection to re activate the immunity

The cost price is not high much less than that of serum and it is easy to vaccinate a large group of individuals Personally I have had my children vaccinated

Practical Application

The question that the practitioner must ask himself is is one to inject A T S or not to a wounded person ? Vaccination should be the ideal procedure but as we have just seen its action is delayed and it cannot prevent the early onset of tetanus

Here are the conclusions reached by the research committee (Fredet P Duval A Gosset Rouvillois and Louis Bazy) (7) and reported to the *Société de Chirurgie* —

In an unvaccinated individual neither the size amount of soiling nor the situation of the wound need be considered and it will then be possible to banish all incertitude

In all cases the practitioner will be able to give an injection of serum but on condition that he gives anatoxin at the same time Immediately after the receipt of the wound he will start by injecting 1 c c of tetanus anatoxin subcutaneously and a quarter of an hour later he will give at least 3 000 units of A T S This last injection should be given in a different site from the previous one In order to prevent any mistake

subjected He was asked by one member if the "method of Lehmann" had been applied at the time of the injection, and when given an answer in the negative, the questioner seemed not at all surprised at the fatal issue Another member asked whether an autopsy had been performed, and on receiving a negative reply, immediately lost all interest in the matter A third member asked if the patient was sitting or lying down, and whether the injection of 2 5 c c had been given slowly or quickly.

Then again, in an important communication to the *Société de Chirurgie*, Louis Bazy (4) gives the results of an enquiry from doctors of the P.-O. railway One hundred and seventy-six doctors answered, saying that out of 755 cases of tetanus, 485 (64·3 per cent) had died *Three per cent of these deaths had occurred despite the administration of A T S* (5) The serum was held responsible for 2 deaths, 2 serious accidents and 14 cases of paralysis, one of which was immobilised for 218 days But the most disturbing fact that emerges from Bazy's statistics is that 70 per cent of the cases of tetanus had not been given serum, *because their wounds were so insignificant that the patients had not even consulted a doctor.* Finally, in 47 cases (6 3 per cent) it was not possible to find a portal of entry.

From these two reports it follows that —

(1) Tetanus can originate from a small superficial abrasion

(2) Serotherapy is not harmless

According to the first premise, serum ought to be given to all small and superficial abrasions, and to burns and Bazy points out, in this connection, that this "tetanophobia" has already manifested itself "A practitioner has given himself nine injections of A T S , a child has already been given fifteen following each fall off his bicycle . . ; the agriculturalists of Selle-sur-Cher give it to themselves and to their workmen systematically following upon each wound that they consider too slight to seek advice"

Unfortunately serotherapy is not without danger Repeated injections of serum not only of the A T S. type but also of all horse serum diminish the immunity and, as has been pointed out by Bazy the more it is repeated the less efficient is the action of the last one and of *all the other therapeutic sera* (6) The deaths and serious complications already referred to, are impressive and so is the case reported by Mauclaire of a patient

who suffered from a paraplegia after an injection of serum and who sued the practitioner who treated her

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it is recommended to *inject the anatoxin in the scapular region, and the serum underneath the skin of either the abdomen or the thigh.*"

"The practitioner will thus be able to safeguard the patient from immediate risks by the serum, and, under cover of this protection, he will be able to confer to the patient a lasting immunity with anatoxin, which necessitates three injections at three weekly intervals, a delay, which can be shortened by giving the injections in a month at the maximum"

"*As only one injection of serum is and ought to be given,* the future of the patient is not at stake, and if a patient, already treated thus, receives another wound, he falls in the following category"

"In patients who have had anatoxin, *there will be no further necessity of giving A T S Another injection of anatoxin* will be sufficient to increase the immunity that is already present There is no danger in giving repeated injections of anatoxin even when wounds are of frequent occurrence, for the immunity increases and becomes more and more marked after each injection"

"In order that immunised or vaccinated persons might be able to make the best of their first dose of anatoxin, it is essential that they should keep a *written record* of previous vaccine injections, they will thus avoid being given serum instead of anatoxin on some future occasion"

In short, it is a question of popularising antitetanic vaccination as much as possible A T S ought to be used as a therapeutic and not as a preventive agent

Unfortunately, at present the usual case is that of a non-vaccinated patient *who has had serum on several previous occasions* Must one, in a similar case, give an injection of serum fifteen minutes after anatoxin, which we admit as indispensable? It brings us back to the same discussion It is beyond dispute that it is quite unnecessary to give A T S to all wounded persons, we have seen the drawbacks, and we have also noted that, according to Bazy, 77 per cent of cases of tetanus had wounds which were so insignificant that they did not even seek advice

Furthermore, it must not be forgotten that, where tetanus is concerned, immediate prevention is only carried out by a surgical procedure The surgeon who simply gives serum and only applies a dressing to a contused wound however small it

may be is completely mistaken The essential surgical act is to excise explore remove foreign bodies and to treat the lesions None of the subungual hæmatomas reported by Berard had been so treated deep lesions had been missed as explorations done later but too late showed only too clearly Böhler states that since he has been in Vienna he has treated 16 000 wounds of the fingers without a single injection of serum and has not had one case of tetanus Imbert of Marseilles reported a series of cases of works accidents *operated on immediately* without a case of tetanus and without a single dose of serum In the coal mines of the North there were 7 cases of tetanus in 150 000 injuries What happened to these cases ? Were they operated on as we insist or were they simply dressed ?

Our opinion concerning wounds of the fingers and hand is therefore that the surgical act is essential If the wound is extensive and irregular if it is difficult to clean and particularly if the intervention is late and if infection is to be feared one must not hesitate to give an injection of A T S while taking the necessary precautions (Besredka) if the patient has had serum previously In other cases if operation is satisfactory it is unnecessary to give serum

If on the other hand the patient refuses the operation that is proposed to him (and this occasionally happens when the lesions are slight) it is absolutely necessary to give anatoxin and serum This will very likely protect the patient against tetanus and the responsibility of the practitioner will be safe guarded

Finally if the wounds are *simple scratches or abrasions* it is truly superfluous to give serum systematically as in the case of the child who received an injection after each fall from his bicycle One should however give anatoxin immediately as it affords an excellent opportunity and will prevent all worry in the future but for the immediate need one should carefully examine and disinfect the wound (mercurochrome is in our opinion the ideal antiseptic for the purpose as it is powerful and painless) and apply an aseptic dressing until healing occurs

In concluding this important chapter we could not do better than quote the remarkable sentences of Bazy If in starting this debate I have brought forward somewhat copious documents it is because I wanted you to say for everyone to

it is recommended to *inject the anatoxin in the scapular region, and the serum underneath the skin of either the abdomen or the thigh* "

" The practitioner will thus be able to safeguard the patient from immediate risks by the serum, and, under cover of this protection, he will be able to confer to the patient a lasting immunity with anatoxin, which necessitates three injections at three weekly intervals, a delay, which can be shortened by giving the injections in a month at the maximum "

" *As only one injection of serum is and ought to be given*, the future of the patient is not at stake, and if a patient, already treated thus, receives another wound, he falls in the following category "

" In patients who have had anatoxin, *there will be no further necessity of giving A T S Another injection of anatoxin* will be sufficient to increase the immunity that is already present There is no danger in giving repeated injections of anatoxin even when wounds are of frequent occurrence, for the immunity increases and becomes more and more marked after each injection "

" In order that immunised or vaccinated persons might be able to make the best of their first dose of anatoxin, it is essential that they should keep a *written record* of previous vaccine injections, they will thus avoid being given serum instead of anatoxin on some future occasion "

In short, it is a question of popularising antitetanic vaccination as much as possible A T S ought to be used as a therapeutic and not as a preventive agent

Unfortunately, at present the usual case is that of a non-vaccinated patient *who has had serum on several previous occasions* Must one, in a similar case, give an injection of serum fifteen minutes after anatoxin, which we admit as indispensable ? It brings us back to the same discussion It is beyond dispute that it is quite unnecessary to give A T S to all wounded persons, we have seen the drawbacks, and we have also noted that, according to Bazy, 77 per cent of cases of tetanus had wounds which were so insignificant that they did not even seek advice

Furthermore, it must not be forgotten that, where tetanus is concerned, immediate prevention is only carried out by a surgical procedure The surgeon who simply gives serum and only applies a dressing to a contused wound however small it

and by leaving them exposed to light and air It follows therefore, that immobilisation can only be effected by placing round the hand a sort of cage, which protects the hand, and which allows the fingers to be fixed to it (v Fig 5) The appliance is easily fashioned with two wire mesh splints which are bent and joined to one another at one end The fingers are suspended well separated and in good position. This appliance has the added advantage of allowing the application of antiseptic powders should some slight œdema or infection in the suture line require it Personally I find it most satisfactory but on the understanding that the patient must be in hospital if he is ambulatory one must protect the lot with gauze and a sling

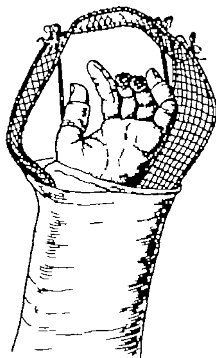


Fig 5 A protective appliance without dressing for a wound of the hand

Appliances with Dressings I intentionally write appliance before dressing because almost all wounds of the fingers and hand must be immobilised on a rigid support The greatest care must be paid to the supports and to their alterations not only when the bones are fractured but also in simple cutaneous



Fig 6 Malleable wire mesh splint. It is the most practical and economical form of splinting and is made in different lengths and widths.

wounds For example one must know how to hold in position with a small lateral wooden splint a skin flap of the finger tip brought about by the extrusion of a fragment of a fracture of the terminal phalanx as the flap sometimes tends to evert itself A wounded finger will be splinted by the metal strips already referred to strips that are very malleable which

know, that a doctor is in his strictest right, and that he is undoubtedly performing his duty *if, when faced with a wound, he refuses to give serum after carefully weighing up the pros and cons in his mind* It must be said that serum, apart from its drawbacks which everyone knows, which might appear to be negligible, possesses the one great inconvenience of compromising the future of patients who have had it, and who are, henceforth, vaccinated against serum ! "

At this particular juncture, I should like to add this the practitioner who, when confronted with a wound of the finger or of the hand, has not treated it surgically and has merely given an injection of serum, has only done part of his duty

Dressing

We propose here to deal with the dressings for an aseptic wound only , the necessary rules of conduct for septic ones will be dealt with in the chapter on "Infections" (p 119 of this book)

Böhler has had it printed on placards in his clinic —

What heals wounds ?
Time
Uninterrupted rest
Circulation

It is essential, therefore, that wounds should not be disturbed This most important point cannot be too strongly emphasised, for it is in direct contradiction with the usual practice of most doctors, of all the nurses and with the notions of all the patients, of all those who imagine or believe that a dressing is a therapeutic act while it is purely a protective agent The dressing must be changed very rarely , every three or four days is quite sufficient provided that it is not dirty, that there is no rise of temperature or that there is no severe pain demanding an inspection of the wound

The usual cotton wool dressing, causing, as it does, a slight compression, makes Bohler fear that it might perturb the circulation , he also accuses it of promoting maceration and œdema of the inflamed parts There is certainly some truth in his arguments

Appliances without Dressings It results that the Viennese surgeon treats the majority of his wounds without dressings,

CASE 18 A young man aged 17 is treated during three weeks for a clean cut wound of the terminal phalanx which has not been stitched An exuberant piece of granulation tissue then appears and increases in size despite cauterisation with silver nitrate and thermocautery He is brought to me by his doctor at the end of six weeks and he then presents the following features At the tip of his index finger is a small papillomatous tumour which is as big as a hazel nut the tumour does not bleed and has *a pedicle which has no connection with the cutaneous edges of the wound* This last feature is a most important diagnostic sign.

Under local anæsthesia the tumour is removed by scooping it out from the bone whence arises its pedicle A stitch is inserted and despite a brisk hæmorrhage during the afternoon of the operation healing occurs in eight days

My teacher Jean Quénu has reported an equally illuminating case in a personal communication It concerned a woman who

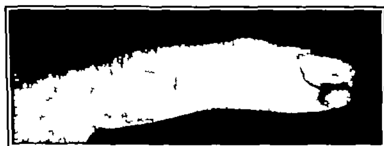


Fig 7 Botryomycoma (pyogenic granuloma) following upon a small infected wound at the edge of the nail Surgical excision was followed by cure in a month.

had been treated *during several months* for a botryomycoma in a wound of the palm of the hand which was thought to be becoming carcinomatous Surgical removal followed by suture of the wound led to a cure in fifteen days

Practitioners must surely be well aware of this particular variety of granulation tissue which literally thrives on caustics and which can only be cured by surgical extirpation These lesions must be recognised early and excised when still small (*v* Fig 7) To sum up a piece of exuberant granulation tissue that persists after two or three applications of silver nitrate must be surgically removed and if possible the wound should be stitched It is a case of secondary suture in very resistant wounds with little sepsis and there is no appreciable danger in so doing

must be made to fit accurately Several injured fingers may be immobilised on a wire-mesh splint so bent that it immobilises the forearm wrist hand and fingers in the position of function · and the fingers ought to be separated from each other by gauze swabs Never roll a piece of gauze round a finger, for when the time comes to remove it one will be at a loss to know where to start and it will cause pain and hæmorrhage Place the finger between the two swabs that separate them

When the thumb is also wounded a tight roll of cotton wool must be placed in the palm the thumb is thus automatically held in abduction

A well-treated wound should heal very rapidly although one must not expect perfect cicatrisation in less than fifteen days even in the most favourable cases At operation it is often difficult to excise completely and accurately beyond the devitalised zone and it often happens that some sutures cut out as a result of gangrene of one of the skin edges These areas heal by secondary intention and become the site of granulations which must be destroyed by the silver nitrate stick (v. p. 122).

When the wound has not been sutured one must wait for all suppuration to clear up for the edges to show signs of healing, for the skin flaps to unite with the underlying structures and for union at the base of the wound before using fatty dressings—five to six days on an average In this way, healing is not interfered with : and the wound does not bleed every time the dressing is changed.

Delay in Healing

A properly treated wound should heal in fifteen to thirty days according to its dimensions if it drags on beyond this period, one must look for the causes

The usual causes of delay are —

Retained Foreign Bodies (particularly bony fragments), **Osteomyelitis** An exploration of the wound and a radiograph will reveal the cause and the removal of the latter will effect a cure

Botryomycoma (pyogenic granuloma). What is conveniently called botryomycoma is a very definite cause of endless delay in the healing of wounds of the fingers Here is a very typical case :—

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6 H VALLÉE and L. BAZY Essai chez l homme de vaccination active contre le tétanos. (*Bull. mém. Soc chir*., t. XLIII pp 1445-1449 1917)—L. BAZY La vaccination antitétanique Essai de généralisation dans une grande collectivité (*Presse méd*., p 1771 21 Juillet 1934) Document pour servir à la prévention du tétanos. Immunisation active par le vaccin ou passive par le sérum ? Discussion : Fredet, Moure, Mauclaire (*Bull mém. Soc chir*., t LXI pp 714-727 1935)

7 FREDET P DUVAL, GOSSET ROUVILLOIS and L. BAZY Rapport de la commission chargée de l étude de la vaccination antitétanique (*Bull. mém Soc chir*., t LXI., pp 902-905 1935)

Secondary Tuberculous Infection. I have had occasion to treat three cases of callous wounds that would not heal, and in which biopsies, taken from the edges, showed the histological lesions of tuberculosis In all three cases, the cause was definitely traumatic, but one could invoke a secondary infection On the off chance, I prescribed the application of U-V rays to the wounds, which eventually healed

As a general rule, I perform a biopsy when a wound shows no signs of healing despite three or four weeks of careful treatment No particular lesion is usually detected, and I have often noticed that the callous state of the wound was due to the poor general health of the patient Hospital treatment, rest and good food, in these cases, effect a cure, which is sometimes very rapid

The Wound that will not Heal This is usually caused by caustics, or mechanical irritation, or even the daily application of dirty dressings The cause is difficult to find by the examination of the wound, it is rather the examination of the patient, his attitude and his appearance that will lead to a provisional diagnosis A final diagnosis can only be made by applying a balsam of Peru dressing covered by a plaster cast, the latter is left in place for eight days despite the usual protests of the patient, who is never tired of coming back to describe the pains he suffers and to show the swelling of his forearm This is the only danger of this form of treatment Redness and swelling proximal to the upper limit of the plaster indicate that the inflammation is spreading, instead of disappearing (an eventuality that I have never seen) and require the removal of the plaster But one must be on the look-out for malingerers who induce great swelling of the forearm by tying a string round it It is, fortunately, easy to detect these cases, as there is a *sharp upper limit to the swelling* As a general rule, always be on guard on seeing a case of very limited peripheral œdema

It is a good plan to sign and date the plaster when the latter is applied Gougerot has reported cases of malingerers who used to remove their plasters, irritate the wounds and then replace the plaster, on which they falsified the original signature But that was during the war (1914–1918), and it would be very exceptional to meet similar cases in civil practice

are unfortunately easily infected, and, as the skin possesses little resistance, progressive infection and ulceration may occur They are also slow of healing so that these minute lesions can lead to incapacity lasting two or three weeks

Wounds with total loss of skin are more difficult to treat When they are extensive and deep healing is naturally slow and leaves a scar that is hard fragile and both painful and insensitive This is why we advise a grafting operation in cases in which the whole thickness of the skin of the palmar surface is lost We use either pedicle grafts taken from the thenar eminence (*v* Fig 9) or free grafts (*v* Fig 10) The choice of the type of graft depends on the

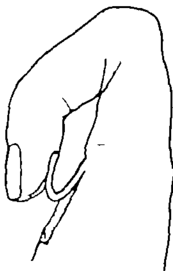


Fig 9 Pedicle graft consisting of the whole thickness of the skin with its underlying cellular and fatty tissue

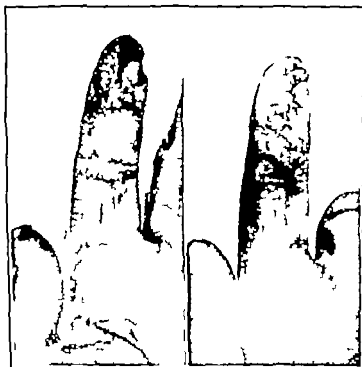


Fig 10 *Left*: Wound of the pulp caused by emery wheel. Immediate free graft under dental wax mould.
Right: The result one month later Healing is complete

CHAPTER II

WOUNDS OF THE FINGERS

Having dealt with the general principles of the treatment of wounds of the fingers and hand in the previous chapter, we shall now proceed to study the treatment of each variety which, according to our experience, is met with in practice

WOUNDS WITHOUT FRACTURES

Wounds affecting only the soft parts vary in extent from a small cut to what we call the "skinned finger", the latter is caused by the bursting of the skin when the finger is severely compressed We shall also deal with wounds caused by aniline pencils, the existence and dangers of which must be known to all practitioners

Scratches or Erosions

We describe, by this term, the loss of surface layers of the skin These lesions are frequently seen after falls and rarely after works' accidents, in the latter case, they are always due to contact of the finger with something revolving quickly



Fig 8 Wound of the pulp without bony lesion (an emery wheel injury)

Usually, there is only abrasion of the epidermis that covers a bony prominence, and this is more often seen on the lateral and dorsal aspects of the fingers Nevertheless, the erosion may be deeper and account for the loss of the whole skin of the pulp of the fingers (*v* Fig 8), leading to exposure of the underlying tissues

The superficial erosions are simply treated by painting them with an antiseptic such as iodine or mercurochrome They

I have always made a point of going to examine these cases they were all failures they were fingers which were ankylosed in semi flexion by the operation scar and which could be flexed *en masse* by the interossei at the metacarpo phalangeal joint We have obtained successes by following a technique that is difficult which has been worked out only after the sad experience of numerous failures It is neither minor surgery nor urgent surgery as it is unfortunately so often labelled in the text books The repair of flexor tendons should only be contemplated under the very best conditions with a rigorous asepsis (the commonest cause of failure being suppuration and as asepsis of the wound is always doubtful primary suture is thereby condemned) and by surgeons who have a special knowledge of this particular technical procedure *It is reparative surgery* and in order to emphasise this funda mental point, we have separated the study of the repair of flexor tendons from that of wounds of the fingers and hand A discussion on the present position of this problem will be found in Vol. II. of this book

Consequently the treatment of wounds with cut flexor tendons should be as follows under anæsthesia and with proper aseptic precautions carefully disinfect the skin explore the lesions remove any foreign bodies that may be present secure hæmostasis regularise the wound edges and dress the wound with the finger in flexion and *without stitching anything* for if the wound is linear the edges of the skin come together without suture and if on the other hand the wound edges are irregular it is still better to leave it to heal spontaneously

The correct emergency treatment of cut flexor tendons is not suture but fixation of the finger in hyper-correction In other words the finger and the wrist will be immobilised in extreme flexion for three weeks by means of a dorsal metal splint (1)

Indeed I have shown that contrary to the classical teaching the distal end of the cut tendon retracts much more than the proximal end which retracts very little When all the joints are put in extreme flexion the distal end is carried to the wound and muscular traction of the proximal end is prevented. In this way the two ends of the cut tendon are approximated and occasionally the approximation is such that spontaneous repair can take place Further and still contrary to the classical teaching spontaneous repair is just as possible in

length of time that has elapsed since the receipt of the wound.

The wound is recent (less than six hours). It is first trimmed like all other wounds, and then covered with a dermo-epidermal graft of a suitable size, which is maintained in position by a dental wax mould The mould is removed on the fourth day, and the wound is then dressed with *tulle-gras*

The wound is already suspect from the point of view of sepsis It is surgically explored and excised, it is then left open and dressed with Dakin's fluid dressings, the grafting operation is only performed after a few days, when the wound is clean and granulating In conjunction with Hechavarria, we have shown that the only graft which is likely to be regularly successful in these cases is the pinch graft of the Davis type Healing occurs in twenty-one days as a rule

If, on the other hand, the wound is small, it should be left alone The time of temporary incapacity is at least three weeks in any type of case

Cuts

Cuts may be superficial or deep The superficial cuts are linear or slightly undercut, their essential characteristic is clean-cut edges, for they are caused by cutting instruments (knives, glass, chips of steel, etc) The deep cuts may sever a neuro-vascular bundle, which is no great importance, or perhaps flexor tendons, which is of very great importance

The treatment follows the general rules already laid down

The Cut is Linear It is cleaned with an antiseptic and dressed It is both unnecessary and dangerous to suture, dangerous because of the everlasting possibility of infection, unnecessary because a linear wound heals spontaneously

The Cut has Raised a Flap The edges are excised if they are contused, and hæmostasis is secured if bleeding is taking place Do not suture on principle unless the flap is long and retracted, but this is a contingency which I have never seen

The Cut has Severed the Flexor Tendons *No attempt must be made to repair them* It is known that the repair of tendons cut in their digital course is so difficult that authors like Savariaud and Bier declare it to be illusory and even advise against it I have personally never seen a good result following primary suture I have, on many occasions and from numerous sources, been told of " successes " following primary suture

from the base of the finger to the pulp and completely exposing the intact flexor tendons As the wound is only an hour old, a careful suture of the deeper layers is performed and the skin edges are regularised and stitched in order to cover the bare tendons Healing occurs in ten days and without complications but the movements of the finger diminish progressively and eventually cease completely

This case demonstrates the harm that these longitudinal wounds can lead to because they block the movement of the flexor tendon even when it is not injured.

The treatment of these lesions is as follows —

In linear wounds—suture the wound if some important

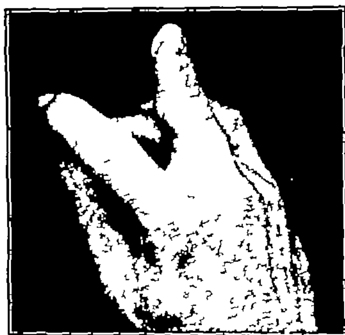


Fig 12 An example of a skinned finger The end result.

structure such as the tendon or the joint is bare and if the time factor is favourable In other cases excise the contused tissues secure hæmostasis leave the wound open and dress it

In skinned fingers—it is best to amputate for there is no skin available to cover the bones Excise the skin until a large healthy flap is available and then amputate or disarticulate the finger at a level where it can be easily covered with skin

Fig 12 illustrates the result obtained by conservative treatment only the projecting end of the bone was slowly but progressively covered by skin but the wound had to be dressed for three months and the ultimate result was bad because the

flexor tendons as it is in extensor tendons, details on this important fact will be found in my article in the *Traité de Chirurgie Orthopédique* and in the second volume of this work

When there is no secondary suppuration of the wound, the repair of the tendons can be undertaken three weeks after healing, but if the opposite is the case, one must wait three months

Bursting of the Skin

This lesion is comparatively rare and is the result of severe compression of the finger The skin of the finger really bursts

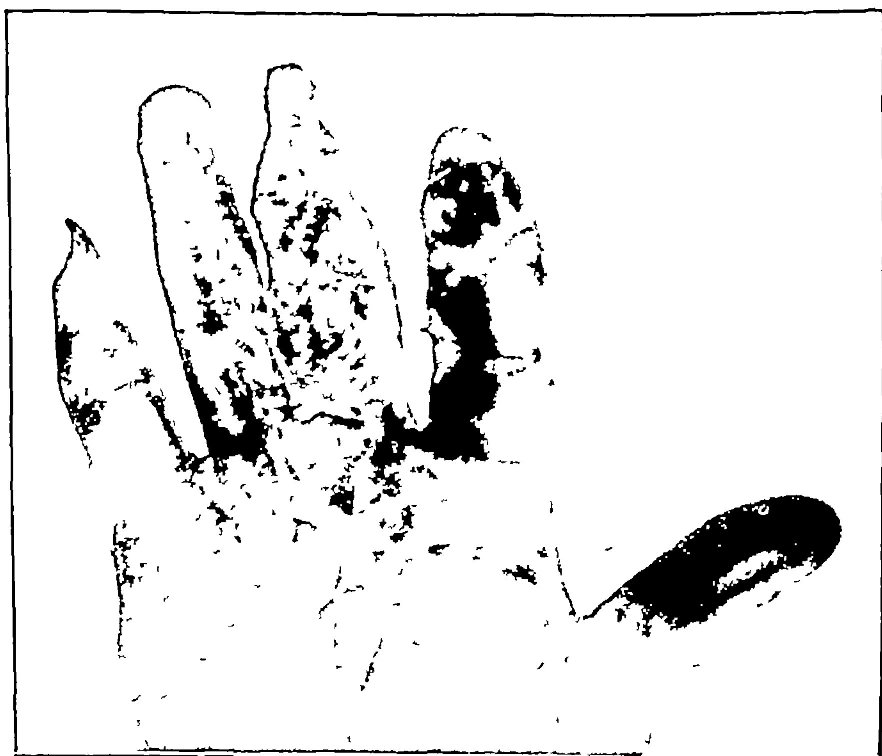


Fig 11 An example of a "skinned" finger

open, and when this occurs in several regions, flaps of skin become detached and leave the bones, tendons and joints bare The flaps of skin are in shreds and of doubtful vitality In other words, it is the "skinned" finger (*v* Fig 11)

A less severe degree of this type of injury only leads to linear wounds of the finger

CASE 19 Ors The finger has been crushed in a rolling mill There is a long linear wound with regular borders, extending

hyperpyrexia etc Immediate *débridement* of the wound is carried out and a large dose of serum sodium persulphate morphine and chloral are given The patient dies twenty four hours after admission despite treatment

It is to be noted that in this case the wound did not look bad it was neither fœtid nor livid there was no inflammatory reaction either around the wound or in the lymph vessels or in the lymph glands there was no suppuration but only a slight blood-stained serous discharge from the punctured wound of the nail.

In the same paper Bérard reports 6 cases of tetanus with four deaths of which only 2 cases showed bony lesions Other fatal cases have also been reported It is obvious therefore that the lesion under consideration ought to be treated seriously

Besides this virulent and fatal infection an ordinary infection may complicate the sub ungual hæmatoma which then behaves exactly like a *paronychia* and the end result of which will be the loss of the nail in about four or five weeks preceded by a mild but continuous suppuration One occasionally sees a large exuberant granulation at the base of the nail a veritable *botryomycoma* (pyogenic granuloma) which can be cured only by complete excision

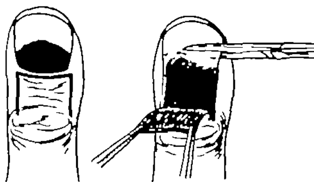


Fig 13 Incision for sub-ungual hæmatoma: section of the detached portion of the nail

Treatment is essentially surgical and it is insufficient to give a simple injection of A T S It is carried out as soon as possible under ring anæsthesia a rectangular flap with a proximal base is raised (v Fig 13) and the matrix of the nail is laid bare the detached portion of the nail is then resected and the contused bed thus exposed. The bone is examined and any *débris* evacuated The wound is left open and dressed In none of the cases that developed tetanus had this line of treatment though very simple been adopted

The results are excellent 15 out of 16 cases healed uneventfully and only one case developed a complication (p 10) which was due to faulty treatment

finger, being encased in hard cicatricial tissue, had lost all suppleness and had become painful and useless

During the last two years I have acquired so much confidence in skin grafts with moulds, because of the regularity with which they "take" and because of the good quality of skin obtained, that I now use them in all losses of skin I have not seen a "skinned" finger for some time, but, should the occasion arise, I would, after adequate surgical treatment of the wound, graft it without hesitation

SUB-UNGUAL HÆMATOMA

The name sub-ungual hæmatoma is given to the common lesion that results from crushing or nipping of the finger-end It is characterised by a dark discoloration of the nail The blood detaches the nail from its bed and is responsible for the discoloration, which is seen on account of the transparency of the nail The comparative frequency of this lesion is 16 cases out of 110

The site of this sub-ungual collection is exactly that of pus in a paronychia, the blood detaches the proximal part of the nail and sometimes leaves the distal extremity intact It is important to emphasise here the frequency and the seriousness of bony lesions that may be associated with these cases The bony lesions are generally fractures of the tip of the terminal phalanx, and we have noted this complication in 4 out of our 16 cases of sub-ungual hæmatomas

The natural end-result is loss of the nail and, if no complication arises, a new nail, more or less deformed, replaces the lost one But *infective complications* are liable to occur and they are *tetanus*, of which Bérard (2) has been able to collect 6 cases The following case, quoted from his paper, illustrates clearly the course of this complication and the anatomical damage found at the time of operation

CASE 20 Fav , 53 years of age, a bricklayer, is wounded on April 13th, 1920 Crush of the terminal phalanx of the left middle finger with puncture of the nail *Sub-ungual hæmatoma* Tincture of iodine and simple dressing without serum

The first signs of tetanus begin with trismus on April 23rd, after an incubation period of ten days Patient is admitted to the Hôtel-Dieu Hospital on the next day with the usual characteristic signs of a very acute type of tetanus marked locking of the jaws, severe crises with episthotonos, generalised contractures, early

hyperpyrexia etc Immediate *débridement* of the wound is carried out and a large dose of serum sodium persulphate morphine and chloral are given The patient dies twenty four hours after admission despite treatment

It is to be noted that in this case the wound did not look bad it was neither fœtid nor livid there was no inflammatory reaction either around the wound or in the lymph vessels or in the lymph glands there was no suppuration but only a slight blood stained serous discharge from the punctured wound of the nail

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WOUNDS CAUSED BY ANILINE PENCILS

Although rare, punctures with aniline pencils deserve to be better known, for non-recognition or improper treatment of these lesions only leads to complete loss of the affected finger by a process of aseptic chemical necrosis, which is brought about by the prolonged presence of aniline particles in the tissues

Frequency In France, I published the first case and since then, these cases have been on the increase (Willmoth and Lubin) They were first described by Erdheim (3) of Vienna in 1920, and his description has since been followed by experimental works and clinical reports, which now number about sixty

Ætiology It is a disease affecting those who work in offices, particularly typists who prick themselves with indelible pencils containing methyl violet

Clinical Features We shall give the details of one of our cases, for it bears out the characteristic features —

CASE 21 A typist, aged 32, accidentally wounded her left thumb with her pencil on September 21st, 1925 The puncture was not

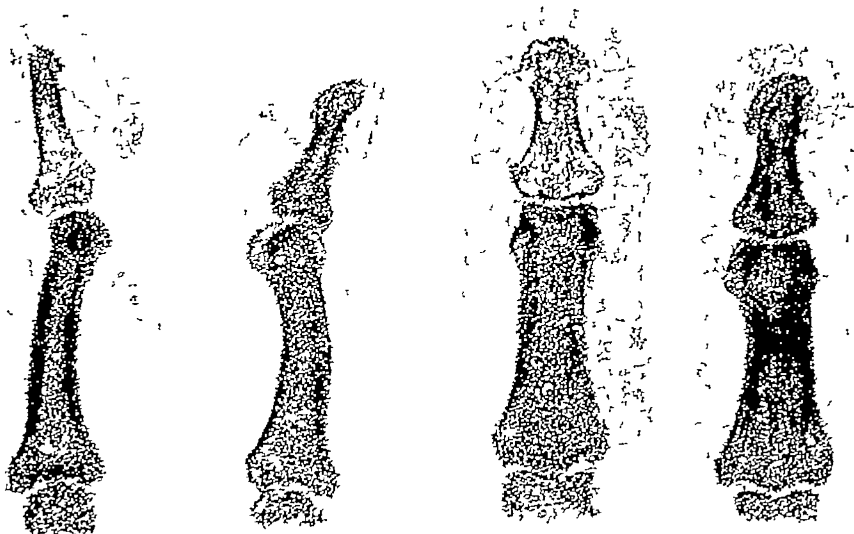


FIG 14 Wounds of the fingers by aniline pencils
Left diseased finger *Right* healthy finger *Left* diseased finger *Right* healthy finger

followed by either inflammation or suppuration A few days later a swelling and blue discoloration of the tissues was noticed

The swelling increased slowly and steadily in size, so much so

that she was operated on at the end of ten days Two small operations were successively performed under local anaesthesia by a practitioner who tried to remove the lead fragment that was under the skin A sinus was the result The sinus exuded a continuous flow of *bluish coloured serum.* All this was marked by an absence of pain and general symptoms

The patient is sent to see me on October 27th There is a callous wound on the dorsal aspect of the terminal phalanx of the index finger The whole wound as well as the dressing is blue in colour

Under local anaesthesia I perform a crucial incision and excise all the discoloured tissues A crater like wound is left open and dressed

The patient returns on November 18th with a callous wound it *has a greyish discoloration and a discharge that is now colourless* A radiograph shows marked decalcification of the terminal phalanx (*v* Fig 14)

As the wound shows no tendency to heal it is on the offchance submitted to the exposure of the U V rays The result is striking after four exposures The wound which had been suppurating for three months is now entirely healed under a small scab The patient sends me a postcard six months later to confirm the cure

Morbid Anatomy The characteristic lesion is one of necrosis caused by the dye which always remains in the wound. Sometimes comparatively large fragments of broken lead remain in the wound In other cases there are merely microscopic particles revealed only by the blue discoloration of the punctured wound The subcutaneous tissues are rapidly invaded and become the site of a serous collection containing a blue liquid The necrosis invades the skin and forms a sinus it also invades the deeper tissues as far as the bone which is eventually destroyed

Histological studies of excised pieces of tissue have been made by Erdheim and these studies have been confirmed experimentally by Glass and Kruger

The necrotic process is entirely aseptic No organisms have been found in the sections and cultures of the serous fluid taken before the onset of sinus formation have been sterile A slight leucocytic reaction is however found around a zone of cellular disintegration and inside a ring of œdema of the surrounding tissues

Experimental Results Much experimental work has been done first by Erdheim then by Torraca on dogs and lastly by Glass and Kruger on the white mouse

WOUNDS CAUSED BY ANILINE PENCILS

Although rare, punctures with aniline pencils deserve to be better known, for non-recognition or improper treatment of these lesions only leads to complete loss of the affected finger by a *process of aseptic chemical necrosis, which is brought* about by the prolonged presence of aniline particles in the tissues

Frequency. In France, I published the first case and since then, these cases have been on the increase (Willmoth and Lubin) They were first described by Erdheim (3) of Vienna in 1920, and his description has since been followed by experimental works and clinical reports, which now number about sixty

Ætiology. It is a disease affecting those who work in offices, particularly typists who prick themselves with indelible pencils containing methyl violet

Clinical Features We shall give the details of one of our cases, for it bears out the characteristic features —

CASE 21 A typist, aged 32, accidentally wounded her left thumb with her pencil on September 21st, 1925 The puncture was not

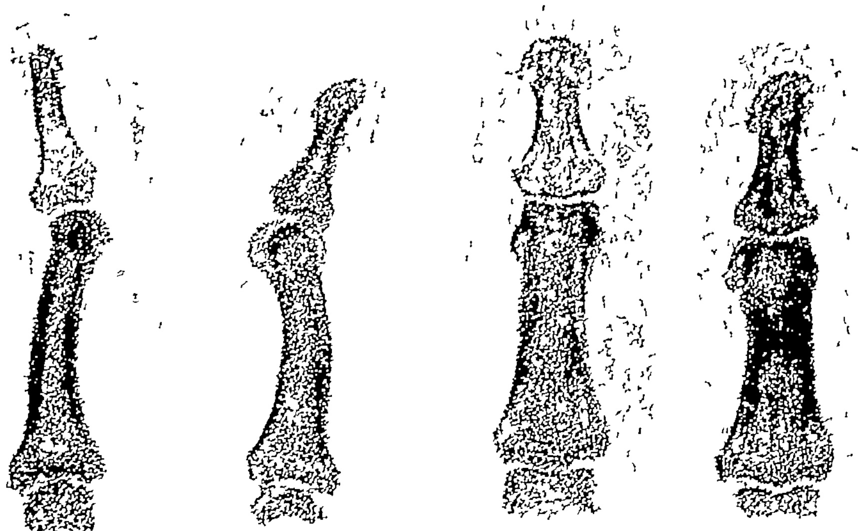


Fig 14 Wounds of the fingers by aniline pencils
Left diseased finger *Left* diseased finger
Right healthy finger *Right* healthy finger

followed by either inflammation or suppuration A few days later a swelling and blue discoloration of the tissues was noticed

The swelling increased slowly and steadily in size, so much so

on the occurrence of general symptoms following upon these wounds As a matter of fact Erdheim has noted, in the majority of his cases a short period of general malaise characterised mainly by fatigue loss of appetite and headache Gartenmeister has reported a case with jaundice This last feature might tempt one to think of a generalised infection but the reports we have quoted and those of Torraca have shown that dyes have almost a selective action on the liver

Accordingly if experimentally it is mainly methylene blue that gives rise to an intoxication it has been shown clinically that methyl violet is just as potent a general poison

Course Duration and End result If untreated the lesion has an unfavourable prognosis Jerusalem s patient had to have his thumb amputated at the interphalangeal joint His second case similarly lost her third finger after the disease had lasted four and a half months

It follows therefore that early operation with a careful and complete removal of the diseased area must be performed The details of the operation will be given later on

Treatment

The treatment is essentially surgical It is important that all practitioners should recognise these lesions and the fact that they demand an immediate operation in view of the grievous functional results that occur in neglected cases

The whole of the discoloured area of tissue must be excised *en masse* It is most important not to try to remove the foreign body with forceps for by so doing there is a great risk of fragmenting the lead and in any case this procedure always leaves behind a large proportion of the necrosing chemical Further according to Glass (the lymphatic drainage of aniline dyes) the periphery of the wound containing the dye is as dangerous as the foreign body itself Moreover in our case reported earlier the excision of all coloured tissues was insufficient to bring about a cure the latter was only brought about by exposure to U V rays

Operative Technique Ring local anaesthesia or general anaesthesia if the wound is too near the hand An incision is made around the periphery of the tumour and all the coloured tissues are excised *en masse* by keeping if possible within healthy tissues If this is impossible or if the dye has already reached the bone the whole area is simply curetted away

Erdheim inserted a 2½-mm piece of lead of an aniline pencil into the abdominal wall of the dog This produced a necrotic area, which measured 3 cm in its circumference and which *did not disappear after the removal of the lead* This is of great importance from the therapeutic point of view

Other chemical substances also induce partial necrosis Glass and Kruger (4), as the result of their work on this subject, have come to the following conclusions methyl violet possesses a powerful local necrotic action Methylene blue has, however, a much more powerful action and causes, in some way or another, a real septicæmia. Other dyes can also produce necrosis and, as will be shown later, cases have been reported in which this occurred following punctures with red pencils and following the entry of industrial and laboratory dyes The problem is, therefore, no longer restricted to aseptic necrosis by aniline pencils only, but one of necrosis caused by a whole variety of chemical substances

Symptomatology

The Mode of Onset The length of time that elapses between the puncture and the onset of symptoms is very variable In Gartenmeister's case the patient was operated on immediately and the piece of lead was removed, but, despite that, the typical blue discharge soon made its appearance and persisted Usually the onset is marked by a little pain, a burning sensation and an œdematous swelling at the site of puncture There is a marked absence of inflammatory reaction , the swelling is pale in colour but the bluish discoloration of the subcutaneous collection can be discerned through the skin

The normal progress of the disease is towards sinus formation, which either occurs spontaneously or follows an incomplete operation The sinus is blue, small and callous The discharge is fairly abundant Jerusalem described a case in which, the puncture having been unrecognised, sinus formation did not occur The patient had come for advice on account of a relatively painless swelling on the dorsal surface of his left thumb The swelling being of a bluish colour, he immediately recognised the lesion

As a general rule the progress of the local lesion occurs without the accompaniment of general symptoms , the disease remains entirely local During the present year, however, some rather important German investigations have laid stress

in Berrocal s (5) thesis They are of two principal anatomical types chip fractures (50) complete fractures (25)

Chip Fractures (v Fig 15)

Usually affect only the tip of the terminal phalanx in which case small bony particles are detached (as in certain cases of

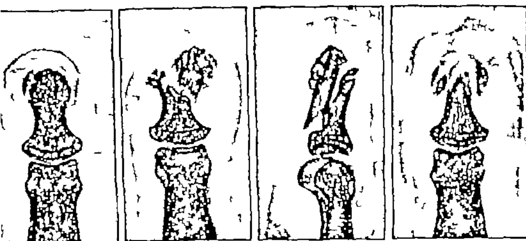


Fig 15 Some types of partial fractures of the terminal phalanx

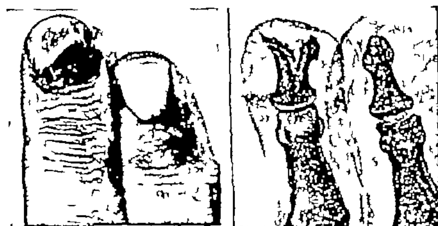


Fig. 16 Typical aspect of a crush with probable fracture of the terminal phalanx. A radiograph confirms the presence of a fracture

sub-ungual hæmatomas) In other cases the small shaft of the diaphysis is affected From the *clinical* point of view one cannot over-emphasise their latency for it is only the systematic exploration of the wound that has shown us their frequency Nevertheless the aspect of the lesion shown in Fig 16 appears to be characteristic enough the nail is cut across in two and the distal end of the finger is deviated downwards and to one

It is useless to suture the wound, it must be left open and dressed with vaseline only. Exposures to U-V rays are then given, this is a form of therapy that gave us an excellent result

Cases

We shall not dwell upon the reports of the 21 cases of Erdheim that formed the basis of his important paper published in 1920 We shall, however, give details of 2 cases that are particularly interesting on account of the sequelæ

CASE 22 (Jerusalem) A young man, aged 22, attends at the beginning of February, 1924 He seeks advice on account of an almost painless and doughy swelling on the dorsal surface of the left thumb The pale and bluish discoloration of the swelling immediately attracts the attention of Jerusalem The patient had been wounded with an aniline pencil three months previously The wound was a minute puncture, which was considered insignificant by his doctor It did not suppurate and was simply dressed, and it healed spontaneously a few days later Soon after, however, it became the starting point of a swelling which slowly but steadily increased in size, and it was at this stage that he was seen by Jerusalem There was necrosis of everything in the vicinity, the skin was slightly affected, the subcutaneous tissues, the extensor tendons and the bone, the last markedly so An amputation of the finger was performed through the proximal phalanx This case illustrates, said Jerusalem, how great is the responsibility of a doctor who was unaware of the existence and the gravity of this type of wound

CASE 23 (Jerusalem) The patient, a young woman, is not seen by Jerusalem until four and a half months after the injury The patient seeks advice on account of a persistent sinus on the lateral aspect of the left middle finger The doctors whom she had previously consulted had failed to recognise the small puncture that was the source of the trouble, and when an operation was performed, necrosis was so extensive that the whole finger had to be amputated

WOUNDS WITH BONY LESIONS

We shall study simultaneously the anatomical characteristics and the treatment of each type of lesion that may occur in each phalanx

Fractures of the Terminal Phalanx

Fractures of the terminal phalanx are by far the most frequent 75 out of our 110 cases treated in 1930 and reported

The *treatment* must be radical If after "ring" anaesthesia and exploration the joint is found to be open one must immediately perform a disarticulation of the terminal phalanx To retain it would only expose the patient to the danger of acute arthritis and at its best would only give a poor end result (painful finger and stiff joint) after long weeks of incapacity The regularised soft parts must completely cover the head of the second phalanx *If the wound is recent* and if one can fashion one or two healthy flaps at the tip there is nothing to prevent suture under cover of a filiform drainage healing will be more rapid and if necessary one can shorten the bone, which the soft parts are unable to cover *If the*

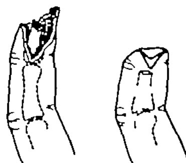


Fig 18 The trimming of a fracture of the phalanx.
Left: The wound before operation
Right: After operation. The soft tissues were first trimmed, the bone was then excised until it could be easily covered with the soft parts In this particular case, this necessitated disarticulation of the terminal phalanx and excision of the head of the second phalanx The wound was left open

wound does not fulfil the required conditions for primary suture leave it open after excising sufficient bone for the soft parts to cover it completely (v Fig 18) healing will then take longer but the length of the finger will be retained We shall discuss the advantages and disadvantages of this method of treatment later on in this book

Fractures of the Two Proximal Phalanges

We group them in the same paragraph because the lesions and their treatment are similar

Their frequency is less than that of fractures of the terminal phalanx 22 cases out of our 110 cases (of which 103 were accompanied with bony lesions)

There are two anatomical types that are quite different

side But a surgical exploration alone can demonstrate the lesion, and Fig 1 (p 6) is a striking example.

To miss those small fractures means exposing the patients to serious troubles, without our mentioning the possibility of tetanus, as in the case of Bérard In a number of our cases a small insignificant wound suppurated for six weeks and a radiograph then demonstrated a fracture One has read on p 3 the impressive case of a man who lost his hand as the result of a small wound of the middle finger which had not been explored, and also that of the unfortunate patient who, during four months, was kept coming and going between doctors and insurance companies because of a crushed thumb, which only healed after the excision of the exuberant callus of a fracture of the distal end of the terminal phalanx (Case 13)

And yet the *treatment* is very simple "ring" anæsthesia, *débridement* of the wound, which must always be done along the lateral aspect of the pulp and never towards the middle line If the wound is on the dorsal aspect, cut and remove the distal part of the nail, this immediately exposes the distal end of the terminal phalanx *The small fragments of bone are now removed* and, if the basal part of the terminal phalanx happens to be denuded, a small portion of it is resected with bone forceps The wound is left open and dressed without attempting hæmostasis, which is impracticable at this level The amount of bone loss will naturally depend on the type of fracture, but, in the majority of cases, there is hardly ever any shortening of the finger or deformity of the nail

Complete Fractures

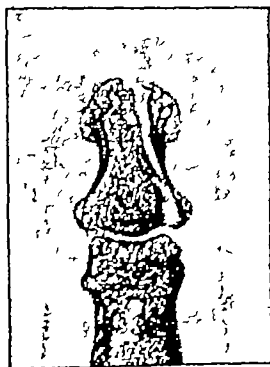


Fig 17 A variety of complete fracture of the terminal phalanx involving the joint

We describe by this term fractures which involve the base of the terminal phalanx and which, therefore, *open the joint* It is rare to see a single fracture with only two fragments, as illustrated in Fig 17, for, very often, there is severe comminution of the bone

The visible damage is usually much more marked than in chip fractures The end of the finger is crushed, hæmorrhage is fairly severe, and that is why we have not seen a case that had been missed

is impossible If the wound is recent, one must content oneself with covering the joints in as far as possible, the rest of the wound being left open But the dressings require great care only substances with a *fatty base* (such as collargol ointment) must be used on the dressing in order that their removal might be painless and the hand must be put in the *position of function* As a matter of fact when the skin loss is replaced by indurated and retracted cicatricial tissue the fingers will never regain their suppleness they will nevertheless retain their mobility as their tendons are intact and they will be useful if they are ankylosed in good position This position is best attained by the simple procedure of placing a roll of cotton wool in the palm and by applying the dressing on the *closed hand*

The time taken for healing depends on the initial operation In a case reported in the first edition of this book, healing took three months and two patients operated on in 1930 for similar lesions were cured in a month

Open Fractures of the Finger

They are more frequent than the preceding variety (16 cases in 1930) They are usually the result of crush injuries (v Fig 20) and rarely due to clean cuts

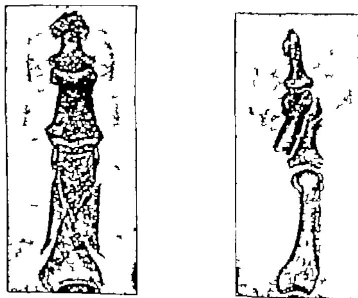


Fig 20 Complete fractures of the first and second phalanges with the typical antero-posterior displacement.

from one another, the incomplete and the complete fracture, the latter variety is also called "compound fracture of the finger"

Incomplete Fractures

We describe, under this term, the traumatic detachment of fragments either from the shaft or from the ends of the phalanx, without breaking the continuity of the bone. We have seen 6 cases (2 epiphyseal and 4 diaphyseal), and they were all caused by spindle-moulding-machine accidents.

Injuries to the soft parts are fairly well marked. The skin is torn into such irregular shreds that it is impossible to

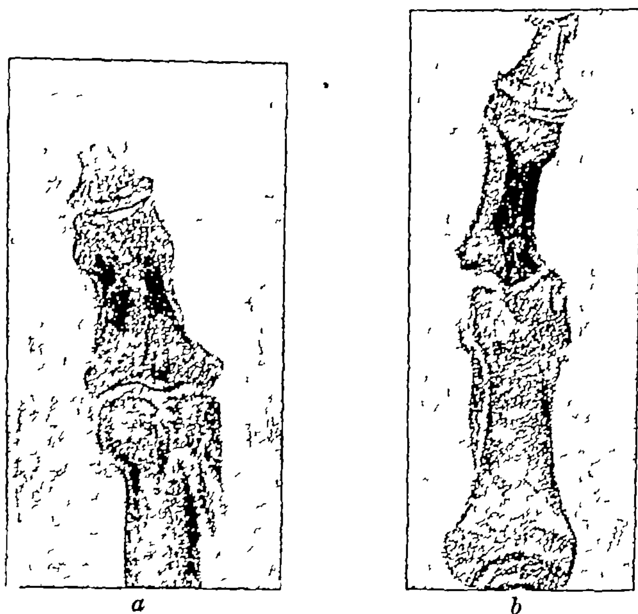


Fig 19 Incomplete fractures of the first and second phalanges
(*a*) Fracture of the head (*b*) Fracture of the shaft

think of bringing the edges together The neuro-vascular bundles are nearly always injured and the corresponding joints opened We have never seen lesions of the tendons

Treatment. A general anæsthetic was necessary in two of our cases (ether is preferable because the operation may be a long one) After all the necessary aseptic precautions have been taken, the cutaneous flaps are regularised, hæmostasis is secured, and the loose bony fragments are removed The skin loss is usually such that a complete closure of the wound

end of the finger hangs by a few threads of skin or by the tendons and is frequently ischæmic

There are two important alternatives to be considered in the treatment conservative treatment or amputation and, if the latter is decided on the level of amputation

Conservative Treatment To retain one or more fingers that are the site of open fractures demands the consideration of three equally difficult points —

The prevention of infection
The proper reduction of the fracture
The preservation of the function of the flexor tendon

The last two points also concern closed fractures and will be fully discussed in Chapter XVIII p 313 The essential thing is the adoption of continuous traction after the technique of Böhler (6) but with the reservations that we have made on the possibility of exercising a real continuous traction In our estimation Böhler s technique *is not a method of reduction but a method of immobilisation* once the fracture has been reduced by suitable manipulations under the X ray screen and under an anæsthetic It is then unnecessary to place the finger in such extreme flexion as is advised by the eminent Viennese surgeon.

The greatest difficulty is the prevention of infection an ordinary infection that imperils only the finger or a generalised infection which may lead to a fatal issue as exemplified by the following case that was treated elsewhere —

CASE 25 The case was in a hospital that I used to visit The surgeon, with whom I often used to discuss the problem of primary suture of wounds of the fingers informed me one day with great exultation that he had just sutured a compound fracture of an index finger while taking the greatest possible care Three days later the patient died from tetanus despite intensive sero therapy

The only possible way of avoiding infection is to operate early excise all contused tissues remove all foreign bodies and then suture the skin and it is essential to carry out all these procedures with the greatest possible care and patience One can then wait for the healing of the soft parts to take place before reducing and splinting the fracture as this avoids contact of the sutured wounds with the plastered splints The fracture becomes a closed one ten to twelve days later and is then reduced under local anæsthesia

CASE 24 When the injury is a cut, the bone and the soft parts are cleanly cut through In an exceptional case seen by my father more than thirty years ago a bookbinder had been cut by a paper-knife, which amputated the medial four digits of the left hand at the level of the middle of the proximal phalanges The bones and extensor tendons were cleanly cut through but fortunately, the flexor tendons and the neuro-vascular bundles were intact The patient having been operated on a quarter of an hour after the accident, it was possible to save the fingers by suturing the skin and repairing the extensor tendons, and the end-result was perfect I know this workman he is still working and has full movements of his fingers

In crush injuries, the damage is much more extensive (*v* Fig 21) The skin is torn and lacerated into shreds, the fracture is comminuted the blood vessels are injured and the



FIG 21 (*a*) Crush of the hand, dorsal aspect

Case S F was unable to come back for another photograph but wrote on November 16th, 1926 · The fingers flex slightly, they are stiff in slight flexion and although weak, they can be used in my work of wood-turning The scars are not painful There is no irradiation of pain except when the part is exposed to the cold in the morning ' Considering the severity of the wound, I am satisfied with the end-result for example, healing took three months This was due to the fact that I had not excised a sufficient amount of bone, which I now consider as essential

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Unfortunately, new difficulties now arise, very often suture of the skin was only possible because the fracture was not reduced If the fracture is so reduced that the phalanx regains its normal length, the scar gives way and gives rise to a gaping wound, which is sometimes large. If the wound is



Fig 21 (*b*) Crush of the hand, palmar aspect

on the dorsum, the harm is not so great, but, if it is on the palmar aspect, how is one to dress it as it lies on the splint? Similarly, it may happen that the damage to the skin, in addition to the surgical excision, leads to a loss of substance that makes suture impossible in either case There is *only one* solution to this problem, and that is an immediate skin graft *A Tiersch graft* is used, it is maintained in position by a dental

wax mould which is accurately adapted to the finger and carefully moulded to the part

One realises from the foregoing that the conservative treatment of compound fractures of the fingers is not within the domain of general practitioners Such lesions are within the scope of experienced surgeons who possess an operating theatre, with its accompanying aseptic materials assistants and X ray apparatus

It is also essential that the surgeon should be able to spare two hours or three if necessary for the operation the reduction and the splinting of the fracture Furthermore the surgeon must be trained in the technique of splinting and grafting All this is quickly and easily learnt by a surgeon who is interested but he must learn it for all that

On the contrary if for some reason or another surgical facilities are not available it is better to amputate the finger rather than preserve it under poor conditions and subject the patient to an immobilisation for weeks if not months in order to obtain a result similar to those obtained in the following cases

CASE 26 An Arab is sent to the Saint-Louis Hospital for treatment on March 1930 The proximal phalanges of two fingers of his right hand had been fractured The wounds were healed the fractures had united in bad position and the fingers were quite useless He demanded an amputation and I complied with his request The temporary incapacity *had lasted nearly six months* whereas if a radical decision had been taken at the outset he would have started work in four to six weeks at the maximum

If the fractures were not reduced it was useless to retain the fingers

CASE 27 Ver 27 years of age engraver is injured on January 18th 1930 There is an open fracture of the middle finger and the patient is seen half an hour after the injury The proximal phalanx is broken obliquely the flexor tendons are intact and the finger-end is well vascularised. As the patient was young intelligent and desirous of preserving his finger I applied continuous traction according to Böhler s technique after having very carefully cleaned the wound and secured hæmostasis without being able to suture it on account of the skin loss The wound became slightly septic and the flexor tendon sloughed out at the end of three weeks. The finger then being useless was amputated The fracture was in good position and nearly united

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reduction of the fracture take once more the strictest aseptic precautions splint the fracture prepare a dental wax mould, cut a good sized thin graft and place it on the wound and cover the latter with the mould which is well fixed by the palmar splint The dental wax mould will be left in position for four weeks At the end of that period the fracture is usually united and the splint and mould are removed

THE FLEXOR TENDONS ARE CUT The problem is more complicated to the existing risks difficulties and time required

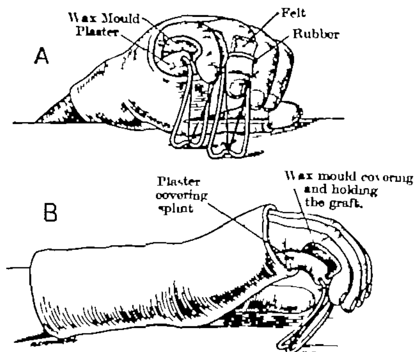


Fig 22. Treatment of a fracture of the phalanges accompanied by loss of skin by means of Böhler's method of extension and grafting under a wax mould.

for the healing of the skin and union of the fracture are now added the risks difficulties and time required for the repair of the tendons which must of necessity be done at a second operation.

The operative indication depends therefore on the lesion, on the goodwill of the surgeon and on that of the patient

If many fingers are fractured there is every reason to attempt the maximum in the case of a single finger the problem is much less pressing Fig 22 illustrates a case of compound fractures of the three medial fingers which were thus treated with great success

The open fracture became infected because I had been unable to approximate too great a gap that was due to skin loss, for at that period (1930) I was unaware of the possibilities of skin grafts with moulds, which are the only recourse in such a case

The following represents my present conception of the operative indications

The Finger-tip is well Vascularised. The patient must be sent to a surgeon as soon as possible, after the application of an aseptic dressing, which comprises a splint to immobilise the fracture If the patient arrives in the required period (less than six hours after the injury), conservative treatment is possible ; if not, it is best to amputate

The time factor being favourable, two types of cases arise the flexor tendons are intact, or not

THE FLEXOR TENDONS ARE INTACT Conservative treatment is absolutely indicated Anæsthesia local, if the wounds affect the fingers only , general, if the hand is also implicated All aseptic precautions are taken, the hand is cleaned with iodised benzine, the wound and the surrounding skin are painted with iodine or mercurochrome (the latter has the advantage of not fixing the blood and therefore permits a good cleaning after the operation)

A thick sterile towel is placed on the table and the hand is placed on this , a sterile towel surrounds the wrist, and the surgeon and his assistant sit on each side of the table

Excision and hæmostasis are performed according to the technique described on p 16 *If suture is possible*, the wound is dressed and a small metal splint bent into the position of function is applied The reduction and splinting of the fracture will be done ten to twelve days later

If suture is impossible, cut a graft, prepare a dental wax mould, and *reduce and splint the fracture immediately*, because a perfect immobilisation is essential if the graft is going to " take " Immediate splinting with wire extension after the reduction of the fracture under the X-ray screen assures both the coaptation of the bony fragments and the success of the cutaneous grafts In such cases, if the patient is treated in hospital, the hand can be left exposed without dressings , but, if he is not, I believe it is better to protect the lot with an aseptic dressing

Finally, the last possibility, *if the scars burst open* during the

in their functional value and the schematic drawing (v Fig 23) taken from Böhler shows how much of the bones can be resected without loss of function

THE TREATMENT OF THE SOFT PARTS The soft parts can be dealt with in one of two ways

Either by fashioning a classical flap to cover the bone end that is the *typical amputation*

Or simply by regularising the edges of the wound and waiting for healing by secondary intention to occur and to cover the bone end that is the *atypical amputation*

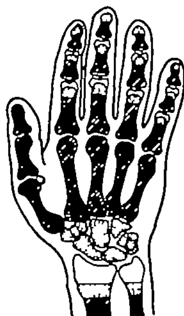


Fig 23 Diagram of amputation levels (after Bohler)

Note that it is important to retain the bases of the phalanges, the site of the tendon insertions.

The typical amputation has the advantage of covering the bone with a resistant and well nourished skin, and of placing the scar on the dorsal or lateral surface Healing takes from three to five weeks and the result is excellent because the resulting stumps are painless and strong and the patients are not afraid to use them

On the other hand much healthy skin is required to fashion a good flap It is not necessary to take it from the palmar aspect if the injury has already fashioned a lateral flap one should make use of it unhesitatingly But as is generally the case the skin and the bones are sectioned at about the same level and the former once regularised cannot be made to cover the bone without undue tension One must then amputate or disarticulate the bone higher up

Therefore if we exclude the rare cases in which the injury itself has fashioned a cutaneous flap one must always sacrifice some bone in order that the skin might be sutured

The atypical amputation has the tremendous advantage of retaining as much of the length of the finger as possible but, as healing over the bone end takes place by secondary intention the resulting scar is situated at the tip of the stump where it

It often happens that the patient is not anxious to have conservative treatment, which will lead to a long period of incapacity and diminished compensation; many will rather ask for an amputation, a rapid return to work and a corresponding increase in their compensation; their interest, therefore, approximates to that of the insurance company. On the other hand, young and intelligent patients who have lucrative jobs needing fine workmanship will themselves demand that the maximum conservative treatment be at least tried.

The goodwill of the surgeon now comes into play. If he does not feel capable of carrying out the whole series of interventions which will be necessary; if it is impossible for him to pass the case on to a more competent colleague, he will have a natural tendency to perform the only reasonable operation, that is, an immediate amputation.

When it is decided to save the finger, the technique to be followed is exactly that which we have just described for the skin and the bones. Two months after complete cicatrisation, the repair of the tendon will be undertaken according to the technique that will be found described in the second volume of this work.

The Finger-end is Ischæmic. An amputation is necessary. Let us recall here that this "radical" procedure depends not only on the vascularity of the finger-end, but also on the length of time that has elapsed since the injury, the amount of damage done and the views of the surgeon.

Amputation having been decided upon, one must now know at what level to amputate, and how to deal with the soft parts; but I should like to insist, from now onwards, *on the necessity of avoiding the later development of neuromas by making a systematic search for the digital nerves, by ligaturing their ends with catgut and by injecting alcohol into them immediately above the ligature.*

LEVEL OF AMPUTATION. The level of bone section entirely depends on the lesions of the soft parts. As the ideal stump is one that is covered with supple and normal skin, it follows that the cutaneous damage may require the sacrifice of more bone than would seem necessary. One is, therefore, obliged to scheme between the desire of keeping as much bone as possible and the necessity of having the bone well covered with skin.

The different parts of the bony skeleton of the finger vary

in their functional value and the schematic drawing (v Fig 23) taken from Böhler shows how much of the bones can be resected without loss of function

THE TREATMENT OF THE SOFT PARTS The soft parts can be dealt with in one of two ways

Either by fashioning a classical flap to cover the bone end, that is the *typical amputation*

Or simply by regularising the edges of the wound and waiting for healing by secondary intention to occur and to cover the bone end that is the *atypical amputation*



Fig 23 Diagram of amputation levels (after Böhler)

Note that it is important to retain the bases of the phalanges, the site of the tendon insertions.

The typical amputation has the advantage of covering the bone with a resistant and well nourished skin and of placing the scar on the dorsal or lateral surface Healing takes from three to five weeks and the result is excellent because the resulting stumps are painless and strong and the patients are not afraid to use them

On the other hand much healthy skin is required to fashion a good flap It is not necessary to take it from the palmar aspect if the injury has already fashioned a lateral flap one should make use of it unhesitatingly But as is generally the case the skin and the bones are sectioned at about the same level, and the former once regularised, cannot be made to cover the bone without undue tension. One must then amputate or disarticulate the bone higher up

Therefore if we exclude the rare cases in which the injury itself has fashioned a cutaneous flap one must always sacrifice some bone in order that the skin might be sutured

The atypical amputation has the tremendous advantage of retaining as much of the length of the finger as possible but as healing over the bone end takes place by secondary intention the resulting scar is situated at the tip of the stump where it

It often happens that the patient is not anxious to have conservative treatment, which will lead to a long period of incapacity and diminished compensation, many will rather ask for an amputation, a rapid return to work and a corresponding increase in their compensation, their interest, therefore, approximates to that of the insurance company On the other hand, young and intelligent patients who have lucrative jobs needing fine workmanship will themselves demand that the maximum conservative treatment be at least tried

The goodwill of the surgeon now comes into play If he does not feel capable of carrying out the whole series of interventions which will be necessary, if it is impossible for him to pass the case on to a more competent colleague, he will have a natural tendency to perform the only reasonable operation, that is, an immediate amputation

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The different parts of the bony skeleton of the finger vary

though it may be weeks longer It is only by studying the end results that the problem can be solved

In 1927 I had seen end results of about fifty wounds of the fingers I saw them in various hospitals where they happened to be in patients for some other reason and in workshops Finally I saw a few old patients who had been treated in the clinics of Lecène, Lenormant and Gosset since 1919 and who reported for examination at my request

The number of cases appears to be small but it is very difficult to trace these patients and many of them do not report because they are afraid that it might mean a reduction of their compensation. Out of 275 cases of all varieties of wounds and infections of the hand collected at that period only 50 reported I had better luck with the 50 cases that I personally followed between 1925 and 1927 and the end results of most of which are known

I was struck by a number of facts

(1) The fingers that retain flexion at the metacarpo phalangeal and first inter phalangeal joints are always useful The patient himself is aware of the fact that it is most important to preserve as much of the finger as possible distal to the first inter phalangeal joint even though the second joint is ankylosed

This type of wound results from clean cuts or crushes localised to the distal phalanges in which no complication has occurred to give rise to an ankylosis of the proximal joint

(2) *The stiff fingers* are the usual end result of wounds with severe cutaneous lesions the joints and tendons are strangled by fibrous tissue and lose all their mobility Ankylosis in the extended position is a formal and classical indication for amputation. Nearly all the amputations that I saw had been done for this reason

But when the fingers are ankylosed in more or less marked flexion the results are often contradictory Some patients do not find the finger a handicap although it is useless and they do not have an amputation performed for fear of another operation. Others on the contrary make good use of their fingers and are grateful to the doctor for having preserved for them a great proportion of function

In this connection I have seen a master of a small workshop who had injured several of his fingers on two separate occasions He had full use of his hand and still carried on with his work although three of his fingers were stiff

adheres Sometimes, one even comes across a true *conical stump*, which is bad, because it cannot stand any pressure, the bone being covered only with a thin layer of epidermis As there are no muscles in the finger and therefore no muscular retraction, the conical stump can only be due to an error in treatment, that is, the exuberant bone end, regularised or not, has been left to be covered by epidermis derived from healing by secondary intention (*v* Fig 12) This ought never to occur if the rules that we have laid down (p 47) are observed, *i e*, if the necessary amount of bone is resected in order that the regularised soft parts might cover it easily

But unfortunately, even when properly operated on, these regularised fingers take a long time to heal and are painful for a long period afterwards I have seen many patients who had had typical and atypical amputations performed years previously, the amputated fingers had never been painful, while the regularised fingers had been for a long time and did not give the sensation of strength, of insensibility and of confidence, which was present in the stumps that were well covered with a flap

Leriche has brought forward another argument in favour of the typical amputation the possibility of secondary neuritis This complication is a true neuritis and is accompanied with a moderate degree of pain and muscular atrophy The pains are quite different from the mild pains usually seen in those cases in which spontaneous healing occurs Among the cases that he quotes in an article in the *Revue de Chirurgie*, not one concerns a non-sutured wound of the fingers, they are all crush injuries Personally, I have not yet seen a case of ascending neuritis entirely due to trauma (I have seen them after whitlows) In two cases the pains originated from a small neuroma, but the wounds had been successfully sutured primarily

Similarly, trophic sequelæ (mainly pain and cyanosis on exposure to cold, necessitating the use of a glove or finger stall) occur with the same frequency in wounds that have been sutured as in those which have not

The crux of the question is, therefore, as follows *Is it in the interest of the patient to retain a longer finger at the price of prolonged incapacity and, ultimately, of some mild pain ?*

Indeed, if the end-result is better, the consideration of a longer temporary incapacity period is of little account even

RESULTS

The end results entirely depend upon the nature of the primary surgical treatment of the wound We shall devote a special chapter (p 105) to this subject the social importance of which cannot be underestimated The model organisation that Böhler has been able to set up in Vienna has given him facilities to treat (or have treated) all wounds of the fingers under the best possible conditions of competence rapidity and attention, which explain the end results obtained results which we propose to quote as an example of what should and could be obtained everywhere

Böhler in his report to the Brussels congress presented a systematic analysis of wounds of the hand and fingers that were treated in his clinic during the second half of the year 1934

He reported 155 cases in which there were 217 wounds with bony lesions (122 had only one fracture but one had two) The majority had other lesions in addition to fractures

74, wound of a joint

17 cut flexor tendon

9 cut extensor tendon

107 extensive loss of skin which made suture impossible

138 of the fractures involved the terminal phalanx and 15 the metacarpals but 64 were true open fractures of the fingers according to our classification of which 42 were at the second phalanx and 22 at the first

Of these 155 cases 98 retained their fingers purely as a result of treatment and 57 were immediately amputated

The Results of Conservative Treatment Primary suture was possible on 67 occasions and only 4 cases showed complica tions (dry gangrene of the finger tip in 2 and infection in the other 2)

Primary suture was not possible on twenty two occasions and skin grafts had to be performed

The duration of hospital and out patient treatment was forty four days on an average (6 7 days of which represented the in patient period)

The Results of Amputations Primary suture was performed on fifty four occasions and three of the wounds became infected

Three wounds were left alone to heal by secondary intention.

The duration of hospital and out patient treatment was

Pollosson and de Rougemont (7), in reporting a case, published a remarkable paper in the *Presse médicale*, from which we borrow some interesting observations.

The involvement of the joint reveals itself soon after the receipt of the injury by *intense* pain and by a thick and ropy discharge, which is synovial fluid.

The wound shows no tendency to heal and infection is the rule, and may even cause a tenosynovitis of the flexor tendon. De Rougemont and Pollosson have seen one case, and, in their anatomical researches, they have been unable to discover any communication between the joint and the tendon sheath. In the chapter on whitlows, however, it will be seen that Kanavel considers this spread of infection as frequent, and that he believes it to be due to the adhesion of the tendon sheath to the metacarpo-phalangeal and first inter-phalangeal joints.

Surgical exploration is the treatment advised by those authors. *If the wound is recent* and there is no pus, it is sufficient to perform *débridement* of the wound, to wash it with ether, to excise the contused parts and to suture the extensor tendon and the skin. *If there is pus in the joint*, they perform a simple arthrotomy with drainage by silkworm gut placed across the joint; and, on this they are very insistent, they *put the finger in plaster* and leave it immobilised for at least nine days. If the latter is not done there is recrudescence of arthritis.

I have already laid too much stress on the dangers of primary suture to subscribe entirely to the conclusions reached by Pollosson and de Rougemont. This question of primary suture only arises in very early wounds, and it all depends on the direction of the wound. *If the wound is a longitudinal one*, it has no tendency to gape, and it is therefore useless to suture it. *If, on the contrary, it is transverse*, the edges separate widely, and it is then preferable to suture and drain the sub-cutaneous tissues with strands of silkworm gut. The suture of the tendon is far from essential, as its large collateral expansions, which receive the insertions of the interossei and the lumbricals, can quite easily make up for the median deficiency.

If, on the other hand, there is already suppurative arthritis, a decision must be reached according to the social position of the patient, his psychical make up and, above all, his goodwill (*v.* Chapter XII, p. 187).

better treated in a properly organised clinic such as Böhler s than by isolated practitioners This is not doubted by anyone but it is not possible to send them all to one clinic on account of their number and the scattered localities at which they occur (v Chapter VII p 105)

Sequelæ

Stiffness Stiffness is a frequent outcome of wounds of the fingers and hand it may be due to a lesion of the joints or of the tendons the latter is less frequent Usually however it is of extra articular origin and the fingers are maintained in any position by the shortening of the capsular ligaments or of bands of cicatricial tissue which we have already described

The return of flexibility in stiff fingers is very uncertain the masseurs to whom I have spoken, and in particular those of the Salpêtrière are unanimously pessimistic Massage baths and mobilisation although *always successful in the treatment of the other fingers that have become stiff through inaction and surrounding inflammation* are utterly useless for the relief of stiffness of the injured fingers themselves Similarly in those stiff fingers in which the wounds have not caused serious injury physiotherapy is always successful

The almost constant occurrence of stiffness emphasises the necessity of putting the fingers in the position of function at the very outset If they remain completely stiff they will be in a good position if they regain some mobility they will be of greater usefulness

The Dangers of Recurring Accidents When a workman has once been injured by a moulding machine a machine press or a revolving wheel, and has thereby lost the exact sensation of the length of his hand does he on account of that run a greater risk of further injury ? The question is of importance because it entails the risk of a change of work, which in itself affects the amount of compensation

I have seen patients who had been repeatedly injured at intervals of several years (five years in one case) one cannot therefore in these cases attribute an inherent clumsiness to the wound

On the other hand workmen have told me that they have seen the same accidents recur in the same individuals but I have been unable to verify the fact

fifty days (6 8 of which represented the in-patient period) It is seen, therefore, that an amputation does not shorten the duration of out-patient treatment

The Influence of Different Surgical Techniques. It is well known that, when wounds are left open, they take longer to heal than when they are sutured, here is the difference in figures

The average time for healing *per primam* is from forty-one days (conservative treatment) against forty-nine (amputation)

The average time for healing *per secundum* is from ninety-seven days (conservative treatment) against sixty-nine (amputation)

When the wound is *grafted*, the incapacity period is longer still fifty-two days in 7 cases of thick grafts and fifty-seven days in 15 cases of thin grafts

A good stump is also of great importance Böhler examined sixty-eight stumps and found eleven unsatisfactory (vicious scars, trophic lesions, misplaced bony fragments and deformed finger-nails), these eleven patients had received treatment for an average period of eighty days, while the average for the others was forty-two days

Lastly, 14 cases had been treated conservatively instead of being amputated at the outset their average healing time was eighty-three days *A poor operative judgment has doubled the incapacity period*

The Influence of Age The age of the patient is an important factor in all wounds of the fingers The average time taken for healing was thirty-four days in those below the age of 26, and sixty-two days in those above the age of 40 The mortality rate (taken from Austrian general statistics) is 0 2 per cent. below the age of 20, and 1 2 per cent above the age of 40 (seventy-one deaths in 6,252 injuries of the fingers) It is true to state, therefore, that more people die from wounds of the fingers than from appendicitis

Böhler proudly compares his statistics with those of Baumann The latter gives the average figure of sixty-five days for healing of an amputated finger in Switzerland It must be mentioned, however, that the statistics of Baumann are drawn from the registers of a large insurance company, the Suwal of Lucerne, and thus includes dissimilar cases treated by different doctors

The conclusion to be drawn is that these wounds are much

CHAPTER III

WOUNDS OF THE THUMB

THERE is no anatomical difference between wounds of the thumb and those of the fingers One will find the same intermediate varieties between the simple erosion the crush of the terminal phalanx and the compound fracture of the phalanx But the operative indications are different because at the thumb an essential part of the hand for gripping one must be as conservative as possible The importance of the thumb as is well known, is so great that when it is missing the hand loses the greater part of its value and becomes comparable to a pair of pincers with one side missing The various procedures adopted for the reconstruction of the missing thumb will be described in the second volume of this book here we shall only concern ourselves with the *immediate treatment* intended to safeguard as much of its length and mobility as possible

Treatment

Purely Cutaneous Wounds The treatment does not differ from what has been described in the preceding chapter

Wounds with incomplete fracture of the terminal phalanx as in the preceding chapter

Wounds with complete Fracture of the Terminal Phalanx involving the Joint. In the case of the fingers we have shown that the joint being open one had to disarticulate at the outset In *the thumb the contrary* is the case and one must adopt conservative treatment Under local anæsthesia the wound is explored loose bony fragments are removed while leaving those that are adherent the contused tissues are excised and the wound is dressed and immobilised on a splint for immobilisation is the only means of preventing the development of infective arthritis When the wound shows signs of healing in about eight to ten days the thumb is encased in a plaster which is left on for at least fifteen days (v p 188) The application of plaster is however not necessary if no signs

I have only seen one young man, aged 19, who had been injured by a stamping press and who had to change his occupation, as he did not feel certain enough of the length of his hand when removing the stamped articles from the press.

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casts a gloomy prognosis If the infection is mild the end result will always be an ankylosis (in good position if the correct treatment has been applied) if it is severe a resection of the joint will have to be performed (*v* p 188) but unfortunately there is a risk of non union occurring between the ends of the proximal phalanx and the broken terminal phalanx with a resulting pseudarthrosis This occurred in case 42 in which a good result was eventually obtained after four months The shortening of the soft parts and the pull of the tendons approximate and hold the two bone ends together

Partial Fracture of the Basal Phalanx Fig 24(*b*) illustrates a type of case that is fairly frequently seen If it is compared with Fig 10 which illustrates the same lesion of the middle finger one realises better the different operative indications In the case of the finger an amputation is indicated but in the case of the thumb the fractured head of the bone only is removed, which realises a resection of the joint and the thumb is then fixed in plaster in the position of function

Complete Fracture of the Basal Phalanx. The operative indications entirely depend on the vascularity of the semi detached portion of the thumb

The End of the Thumb is Ischæmic It is impossible to avoid immediate amputation, but the fractured bone will be regularised as little as possible by removing only the projecting sharp points If enough skin is available to cover the bone end and if it is possible to suture the skin without tension the wound is closed but usually this will be impossible and the bone end will project beyond the excised soft parts In such a case and contrarily to what we have said for the fingers *one respects the projecting end of the bone* which will have to be covered by a skin graft

A more complete discussion on the indications and choice of grafts will be found later on but we shall give the essential points here We believe that a *pedicle graft* taken from the abdominal skin is essential to make good the loss of substance and to cover the bone But *the operation must not be a primary one* we have records of two cases in which primary grafting was performed and proved unsuccessful. In those cases the abdomen was first prepared and an incision made into the skin the thumb was then placed under the skin a flap was then fashioned by another incision and eventually the pedicle of the flap was cut Suppuration occurred and some of the sutures

of arthritis are present at the end of eight to ten days Figs 24(*a*) and 24(*b*) illustrate two typical cases

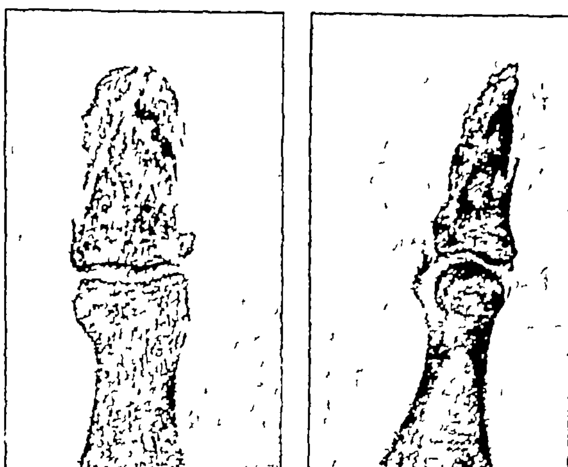


Fig 24 (*a*) Diaphyseal fracture of the terminal phalanx of the thumb treated conservatively *Right* the end-result

The end-results entirely depend on the articular infection If no infection of the joint occurs, the fracture evolves satis-

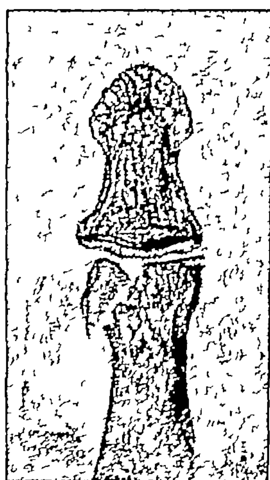


Fig 24 (*b*) Incomplete fracture of the head of the proximal phalanx

Compare the operative indication here with that of Fig 19 (*a*) (a similar lesion of the middle finger) At the thumb, resect the joint and encase in plaster At the middle finger, amputate on principle

factorily It may sometimes remain painful for some months (*v* Fig 26), but this is of no importance, since the thumb is otherwise normal The development of arthritis immediately

the flap to the palmar edge of the wound *Fifteen days later* at a maximum one can cut the pedicle and liberate the patient Healing takes six weeks at the most Fig 25 illustrates the wound before treatment and six weeks later when the projecting end of the bone was completely covered by skin taken from the abdomen [1]

In another type of case the lesions are more extensive, the palm of the hand and the other fingers are also injured. The problem of grafting these areas can be solved differently, and as they are really *wounds of the hand* they will be dealt with in the next chapter

THE END OF THE THUMB IS WELL VASCULARISED A large and healthy bridge of tissue intervenes between it and the rest of the thumb and the tendons are intact Contrary to what we have said concerning the fingers in the previous chapter, the thumb must be preserved Two types of cases are seen

(a) *The wound is recent* after excision regularisation of contused tissues removal of loose pieces of bone and foreign bodies, the fracture is reduced and the wound is stitched stitching has the added advantage of maintaining contact between the fractured ends immobilisation is then effected by a small splint which also keeps the dressing in place

(b) *The wound is too old* for primary suture in addition to being more than usually soiled and ragged The thumb must nevertheless be saved Surgical excision of the wound is performed and the thumb is immobilised after the technique of Böhler

[1] For details of technique, see Vol. II. of the book.

between the thumb and the abdominal skin gave way, so that the patient had to put up with the fixation of his hand to the abdomen for six weeks The final result, in itself, was satisfactory, but it could have been obtained with much less inconvenience to the patient if the grafting had been deferred to a *second operation*, and if it had been done according to the

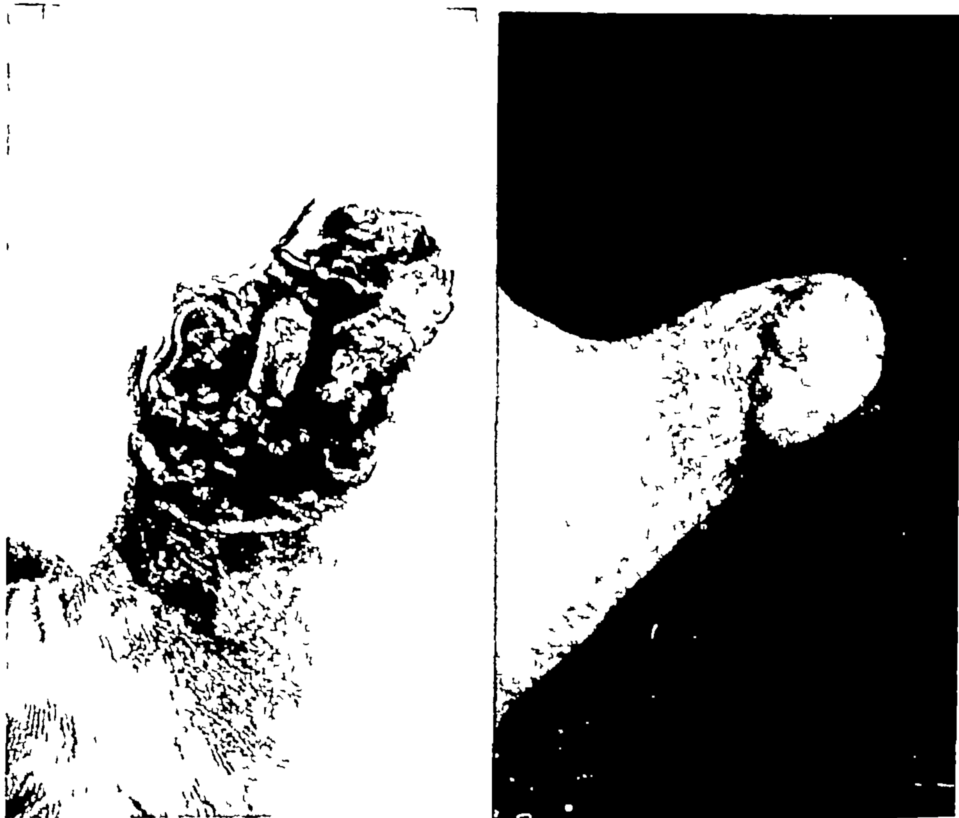


Fig 25 Treatment of a compound fracture of the proximal phalanx of the thumb

Contrarily to diagram, Fig 18, one must, here, retain as much of the bone as possible and cover it with a graft taken from the skin of the abdomen *Right* the end result

following technique, which is described very briefly The aim of the first operation is, as always, to prevent serious infection and its accompanying complications by a careful preparation of the wound (trimming, excision of contused tissues and removal of foreign bodies), and this is followed by the application of an antiseptic and fatty dressing (collargol ointment seems to us to be excellent) Meanwhile, the flap is prepared and applied, on the eighth or tenth day, when the wound has passed the phase of elimination, by suturing the free edge of

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CHAPTER IV

WOUNDS OF THE HANDS

We shall give separate consideration to wounds of the dorsal aspect and to those of the palmar surface, for their character and their treatment are quite different.

WOUNDS OF THE PALMAR ASPECT

These wounds must be further subdivided into varieties according to the three different anatomical regions of the palm of the hand . the middle palmar region, devoid of muscles, but containing all the flexor tendons, blood vessels and nerves of the fingers , on each side of it, the thenar and hypothenar eminences, thick and muscled

Wounds of the Thenar Eminence

Surgical Anatomy

The seriousness depends on the depth of the wounds

Cutaneous or musculo-cutaneous wounds, in which no important structure is injured

Deep wounds, with section of the *tendon*

Wounds with fracture of the metacarpal

Serious wounds (gun-shot and machine injuries) which involve not only the thenar eminence, but also the neighbouring region of the hand and mutilate one or more fingers.

Treatment

Anæsthesia In superficial wounds, an infiltration of a local anæsthetic, which is introduced by pricking the cut edges of the wound, is quite sufficient In doubtful cases or in deep wounds, a general anæsthetic is necessary

Superficial Wound The wound is cleaned and excised , it is then sutured or not according to the " age " of the lesion

Deep Wound without Lesion of the Tendon If the time factor is favourable it is best to suture for cicatrisation is more rapid and the following anatomical factors are in its favour no undermining of the skin on account of its adhesion to the deep fascia, the elasticity of the part allows for easy suturing, lesion of the muscles which are resistant to infection particularly when the contused parts have been well excised.

CASE 28 (Dr Sénèque) L. is wounded on October 20th 1925 Wound of the thenar eminence with section of the muscles down to the adductor which is intact Operation three hours after the accident General anæsthesia excision, suture with a single catgut stitch in a wide U and a single silkworm gut stitch for the skin followed by spirit dressing

The patient is seen again on October 25th, the thenar eminence is supple and the wound is linear On November 15th the result is perfect and function is complete

If the above conditions are not fulfilled, it is better not to suture the wound as in the following case

CASE 29 Marcel S 18 years of age is injured on August 27th in a cycle accident Wound at the base of the left thumb along the flexion crease and involving half the circumference of the finger The wound is deep and exposes the flexor tendon, which is not injured. It is left open and dressed. It is healed on September 14th (eighteen days) The scar is linear and non adherent and similar to that obtained following suture

Wounds with Tendinous Lesions We have already pointed out in connection with tendons cut at the level of the fingers that primary suture ought not to be done on principle The primary operation will, therefore be exactly the same as in the preceding paragraph without making any attempt at repairing the tendon The repair will be done three to five weeks after complete cicatrisation

Wounds with Bony Lesions Case 1 quoted at the beginning of the book, illustrates the complications that can supervene after a similar lesion The treatment is however very simple and follows the general rules exploration of the wound removal of free bony fragments and foreign bodies regularisation of the bone ends and excision of all contused parts of the skin and muscles Finally if the wound is recent and not ragged suture it if it is irregular and soiled (*particularly*

after street accidents) and, moreover, if it is not recent, it is wiser to leave it open and dress it In all cases, a splint must be applied in order to maintain the fracture in the best possible position

Wounds with Articular Lesions. If the *trapezium-metacarpal joint is opened,* it does not in any way affect the therapeutic indications just given, but the danger of arthritis aggravates the prognosis In any case, it is prudent to immobilise the



Fig 26 **Digital cheiroplasty**

The index finger was completely crushed at the base by a printing press, the wound was dorsal and the digital blood vessels were intact The bones of the finger were removed through a dorsal incision and the skin of the palmar aspect of the finger was used to cover the wound already excised Immediate suture Healing *per primam* Perfect functional result

wrist joint in the position of function with a splint, and to replace the splint with plaster if signs of arthritis appear

Wounds Extending to the Middle Palmar Region The lesions in this type of wound are often so severe that the grave possibility of primary amputation has to be considered

Such a decision must not, however, be hurried, as it is only a systematic exploration that will show if a few of the fingers can be saved The operation always follows the same rules exploration, removal of loose pieces of bone and foreign bodies, and excision of all contused tissues Any finger that has lost

its blood supply and is therefore cold and purple must naturally be sacrificed along with its metacarpal which is removed up to its base Care must be taken not to remove the base of the metacarpal, for by so doing the wrist joint would be opened and endangered It is only after the removal of the metacarpal that thick and well vascularised flaps can be fashioned to cover the wound and if possible sutured Should the latter be found to be impossible the wound is left open with the flaps in position and is simply dressed.

The covering of the raw areas is the particular problem to be solved in these cases and it is impossible to lay down definite rules regarding it The choice of flaps must naturally, depend on the position and the extent of the wound There is however an excellent procedure *digital cheiroplasty* which may be carried out either at the outset or at a later date

The aim of this procedure is to utilise the skin of a finger that is wounded or useless in order to cover a cutaneous surface (Carcassonne) It was first described by Desseix in 1761 redescribed by Verneuil and subsequently applied by Courty Boeckel, Guermonprez E Quénu (1) devoted a special article to it during the war of 1914–18 and Camper (2) wrote a thesis on it at the suggestion of Professor Tixier of Lyons It consists essentially in removing the bones of one or more fingers whose metacarpals and tendons are injured *but whose blood vessels are intact* otherwise the skin is destined to gangrene A large and well vascularised flap is thus obtained, and is folded towards the palm to cover the bare areas

Carcassonne has established the strict rule of only performing this operation secondarily after a long enough period of dressings, for infection is one of the dangers of this operation We subscribe in principle to this statement but if the wound is operated on soon after the injury it is wise to perform a complete excision at the very outset to leave no bony fragments and to remove immediately the bony skeleton of the finger to be sacrificed (as it is so difficult in the present state of our knowledge to repair the tendon and the metacarpal at the same time) The flap obtained by the removal of bones can be placed in position without difficulty and fixed there by a few stitches under cover of drainage But once again this closure by primary suture must only be contemplated when the operation is performed early and after careful preliminary

preparation of the wound, without forgetting the preventive injection of A T S

Wounds of the Hypothenar Eminence

The absence of tendons in this region and the thickness of the soft parts that cushion the fifth metacarpal bone account for the wounds being much less severe in this region than in the thenar eminence The wounds that I have encountered in this region, although few in number, have all been musculo-cutaneous ones and have healed very rapidly following the treatment carried out according to the rules already laid down

Wounds of the Middle Palmar Region

Cutaneous Wounds. They are, as a general rule, linear in type and are caused by cutting instruments (glass, knives, etc), although these instruments occasionally raise a flap Circular saws inflict wounds that are large, with rectilinear flaps and bruising of the skin over an area varying from ½ to 1 cm in breadth

It is essential to have a perfect anæsthesia, for the exploration of the wound must be very thorough A local anæsthetic will answer the purpose provided it is injected through the cut edges of the wound and is well infiltrated under the flaps

Excision of the contused tissues is performed, hæmostasis is secured, and it is *unnecessary to suture the wound* because the skin is very thick and very adherent to the underlying deep fascia in this region The difficulties of dissecting the skin from the underlying palmar aponeurosis are well known , the edges of the wound are practically never detached from the underlying structures and, therefore, show no tendency to gape A linear wound remains linear and a large wound does not become larger The wound illustrated in Fig 27 was not sutured , it was healed in twenty days, leaving a fine linear scar

If, on the other hand, suture is to be performed when there is loss of substance, one must either undercut this adherent skin which does not give, with a consequent risk of a hæmatomas infection and later disruption of the wound, or bring the bodies, of the wound together by flexing the fingers which that has lost

forth be maintained in that position The risks of disruption infection and retracted scars with the fingers in flexion are too great and are not to be compared with the good results that follow simple dressing of the wound without suture

Wounds with Lesions of the Tendons The damage is extensive and varies with the causative agent and the site of the hand affected Indeed Bloch and Bonnet rightly distinguish two regions *the distal palmar region* situated in front of the heads of the metacarpals At this level the tendons are diverging to the fingers are well separated from one another and lie in the distal osteo aponeurotic grooves (the proximal ends of which, it is worth recalling *are level with the distal palmar crease)* Consequently the number of tendons cut is never large (two at the most in our cases) but the difficulties of repair are very great as will be shown in a special chapter of the second volume of this book

The proximal palmar region corresponds to the hollow of the hand and is bounded proximally by the flexor retinaculum The tendons are very closely packed and enclosed in a common sheath the ulnar bursa A comparatively small wound can therefore cut six or seven tendons and even eight in some of our cases On the other hand the chances of repair are better the cut ends of the tendons retract little for they are maintained in place by their synovial covering This latter structure is as has been shown by Rochet Folliasson Tailhefer etc also useful in covering them after suture

Treatment

Wounds of the distal palmar region must be explored hæmostasis secured the nerves repaired if they are cut the contused tissues excised and then if the wound is recent one can suture the skin to protect the cut ends of the tendons but without making the *slightest attempt at bringing the latter together The repair of the tendon must be done at a later date*

Secondary suture of the tendons is disappointing enough even under the best possible circumstances and if it is carried out as an urgency and under uncertain aseptic conditions the results are deplorable for each successful case published, I a four that are complete failures Further once it has closure becomes most difficult for psychological reasons to the operator attempt at repair The majority of these

patients, having been injured at work, do not believe in further operations which lead to a great loss of time, although these are intended to diminish their incapacity Let us take an example a wound of the palm of the hand with section of two flexor tendons, immediate repair is followed by slight suppuration A month later one must bow to the fact that fibrous tissue unites the skin, the tendons and the soft parts in one solid mass and that failure is complete Before another attempt at repair can be made, one will have to wait six weeks or two months, according to the degree of suppuration The end-result is, therefore, three months wasted plus the prospect of another operation now rendered more difficult and risky Another drawback of immediate tendon suture is the method of access, the wound being necessarily used for this purpose Consequently, when the wound is stitched, the cutaneous and aponeurotic scar is exactly superficial to that of the tendon, and this is the ideal condition for fusion of the different layers in a mass of fibrous tissue and this also, we have already seen, is the commonest cause of failure

Let us suppose, on the other hand, that the same wound is treated according to the rules given here cleaning, excision, hæmostasis, suture of the skin if the conditions are favourable and, if not, simple dressing without suture Fifteen days later the wound is healed, there has been no suppuration and the scar is supple One month later and with the best possible prospects of success, suture is performed through small incisions placed at a distance from the site of section of the tendon

Repair of the Nerves It is useless to insist on the fact that if the fingers are to be useful they must retain their sensations One anæsthetic finger, even though it is completely mobile, is useless, but it does not get in the way Two anæsthetic fingers, however, constitute a true infirmity This is the reason why, at the time of the primary operation, one must find the nerve ends and repair them with the same care as is taken in looking for bleeding points and securing a perfect hæmostasis The nerves are, naturally, small, but their suture is possible , and as they are entirely sensory, the results are always satisfactory It takes six to twelve months for the complete return of sensation (Sterling Bunnel)

Wounds of the proximal palmar region are, on the contrary, quite suitable for primary suture on condition that the wound is a clean cut, that it is recent and that the operation is per-

formed by a trained surgeon under the best possible conditions It is not an operation to be performed on the corner of a table under local anaesthesia and with gloves hurriedly put on hands that have not been properly washed Every facility afforded by a well-equipped operating theatre must be utilised the patient must be given a general anaesthetic an Esmarch bandage must be applied the patient s hand must be carefully cleaned painted with iodine wrapped in sterilised towels and placed on a table covered by sterilised cloths Two assistants special instruments and needles previously threaded on both ends of the suture material should be available All these go to simplify an operation which is always long and delicate

It is my feeling therefore that tendon suture should only be performed primarily *when the wound is situated in the proximal palmar region* and when the best possible conditions just referred to are available (The technical details will be found in Vol II of this book) If those prescribed conditions cannot be fulfilled it is better to wait two weeks before attempting tendon suture

Wounds with Bony Lesions The traumatic agent has cut through all the layers of the palm of the hand including the nerves and tendons before breaking the bones The fingers corresponding to the fractured metacarpals have no further value and are often already cold and cyanotic on account of some injury to their blood supply but occasionally the blood vessels are spared

If the fingers are still supplied with blood if ischaemia is not obvious one must be in no hurry to perform an amputation I used to hold the view that it was impossible to repair at the same time the bones which must be immobilised and the tendons which must be mobilised (Sterling Bunnel) but I now consider that it is essential to try conservative treatment

The wound will be treated as usual hæmostasis having been secured, the nerves are searched for and immediately sutured the skin is then sutured and the hand is immobilised on a dorsal splint until healing occurs The case will then be treated as a closed fracture If during the succeeding days one or more fingers become gangrenous it will be time enough to amputate them It is not the rule for I have seen fingers survive on the accessory dorsal blood vessels only

in a case in which the palm had been completely cut across (*v* Fig 27)

Six or eight weeks later, the bones are united, the wounds healed and the nerves in the process of regeneration, one may



Fig 27 Transverse wound of the palm of the hand inflicted by a circular saw It extended down to the bones The second metacarpal was cut across at the neck and the index finger, which was hanging off, was amputated All the soft parts had been cut through Conservative treatment was, nevertheless, attempted, and the blood supply of the fingers was assured by dorsal collaterals The nerves and tendons were repaired at a second operation

then proceed with the repair of the tendon with good prospects of success

If the wound is one in which the skin and the bones are badly mutilated (gun-shot injuries, or accident (3)), it is impossible to cover the parts and the occurrence of infection is certain If one or two fingers are imperilled, it is best to

remove them, but if the whole hand is at stake it is wise to adopt conservative treatment to the bitter end This type of treatment will demand a great effort on the part of the patient and much goodwill on the part of the surgeon. The following procedure may be adopted skin grafting of the wound by a pedicle flap taken from the patient s back. Once the hand is free it is splinted and continuous traction is applied to the fingers in order to prevent retractions and deformities An Albee graft is placed in the bones that are not united Finally tendon repair

If it has not been possible to cover the wound with skin infection becomes more or less a certainty and as soon as it has manifested itself one must amputate any imperilled finger I have seen many patients whose fingers had been retained despite infection and despite the fact that the corresponding tendons and metacarpals were respectively cut and fractured chronic infection resulted and a secondary amputation of these swollen deformed immobile and insensitive fingers had to be performed

WOUNDS OF THE DORSAL SURFACE

We shall study the wounds of the dorsal surface according to the same scheme as that adopted for palmar wounds that is to say by classifying them according to their depth, while laying particular stress on wounds of the joints (metacarpo phalangeal and wrist) which are particularly liable to injury on account of their superficial situation.

Simple Cutaneous Wounds

The skin of the dorsum of the hand being thin and mobile is very easily detached by trauma which is usually applied obliquely or even at a tangent This is why these wounds remain superficial and are rounded or angular in shape determining a flap of skin which is detached for a varying distance from the underlying structures The edges are either *sharp and cleanly cut through* or *contused* in the latter case excision leads to marked loss of substance

The treatment may be carried out under *local anæsthesia* which is very satisfactory on the dorsum of the hand As

always, it consists in exploring the lesions and excising the contused tissues On principle, suture must only be done if the wound is recent, and if the edges come together easily after excision, and in every case, it is a wise precaution to provide drainage If the wound is closed without exploration



Fig 28 (*a*) A wound of the dorsum of the hand

and excision, infection may invade the whole undermined area of the skin witness Case 2 (p 1) in which the wound was only ten minutes " old " and had been inflicted on the bare hand by a piece of glass, but the semi-circular wound was accompanied with undermining of the skin, which was not detected

CASE 30 Fig 28 illustrates the hand of carter who had been injured by the crank handle of his lorry The blow had torn the

skin the edges of which were cut very obliquely and the extensor tendons were exposed in the base of the wound. The accident had occurred in the street and everything was very soiled Primary suture in such a case would have necessitated a large excision of the skin with corresponding loss of substance If infection had

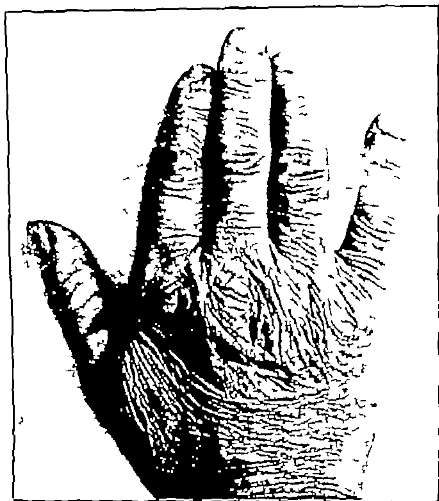


Fig 28 (*b*) Same wound of the dorsum of the hand. Healing in a month following simple dressings without suture

occurred as it frequently does after street accidents (Desplas) the sutures would have given way and the ensuing raw surface to be covered would have been larger than ever In the face of this I decided to explore the wound excise the edges leave it open and dress it One month later it was almost healed and the end result was excellent The tendons were functioning normally and the skin was not adherent to the underlying parts

CASE 31 Injured on September 17th, 1926, by having his hand trapped underneath a barrel Contused wound with undermining of the skin, the wound was situated 2 cm proximal to the third metacarpo-phalangeal joint It was explored under local anæsthesia, being bow-shaped, it was enlarged and no lesion of the metacarpo-phalangeal joint was found It was left open and dressed Rapid healing The patient was discharged on October 5th, *eighteen days after the injury*

The method of performing the dressings is so important that I repeat again they must be infrequent, non-antiseptic, but fatty, once the wound shows signs of healing One often sees wounds dragging on for weeks merely owing to the daily application of irritating dressings

Wounds with Lesions of the Tendons

The suture of extensor tendons presents none of the difficulties encountered with the flexor tendons (synovial sheaths, pulleys of fibrous flexor sheaths, etc), and this is why it gives, as a general rule, excellent end-results, especially when it is performed at the level of the metacarpal bones At this level, the tendons are united to one another by aponeurotic extensions, which prevent retraction of their ends and which can compensate one another to some extent All this makes repair easier and gives a good final prognosis

Accordingly, *if the wound is recent*, if it is a clean cut wound which can be easily sutured, the tendons must be repaired and the skin sutured without drainage

If, on the contrary, *the "age" of the wound, its irregularity* and the skin loss make one fear the development of infection, it is wise to leave it open after adequate preliminary treatment The tendons will have to be repaired at a later date

Primary suture gives, on an average, very good results However, out of nine lesions of the extensor tendons treated in 1930, four were failures and had to be re-sutured Among these four re-sutured cases, one failed on account of disunion and localised gangrene of the skin in a small area, which corresponded to the junction of three cicatrices (those of the wound, of the first and of the second operation), and this is the reason why I now use somewhat special incisions

Wounds with Bony Lesions

The seriousness of these wounds depends on whether or not the palm of the hand is involved in the lesion We shall not deal with wounds associated with those of the palm because the damage in the latter situation is such that the dorsal wound becomes comparatively insignificant and because the treatment of those wounds is exactly the same as that described on p 79

When, on the other hand, the wound is confined to the dorsum of the hand the problem is to repair both the tendons and the bones

The lesions of the skin and of the tendons are similar to those we have just described. The number of metacarpals fractured varies but the displacement of the fragments is always the same The traumatic agent drives the fragments forward so that they tend to produce an anterior projection, which impedes the play of the tendons and which makes grasping difficult

A general anaesthetic is indispensable The fractures are reduced after exploration of the wound and after the removal of loose bony fragments and foreign bodies The maintenance of a good position in those fractures is sometimes difficult without synthesis which in these small bones is easily carried out by passing a stout silk thread through two small holes The skin is sutured or not according to the case One must remember however that *one cannot repair at the same time the bone which must be immobilised and the tendons which must be mobilised* so that the suture of the tendons will have to be performed at a later date

In every case a tight roll of cotton wool must be placed in the palm of the hand in order that the broken metacarpals may retain their precious anterior concavity their pronator curve

Wounds with Articular Lesions

Lesions of the Metacarpo phalangeal Joints

As the head of the metacarpal juts out when the hand is closed this joint is the seat of election for articular wounds

The *lesions* of the skin are sometimes minimal (cuts), sometimes severe (circular saws) (*v* Fig 29) The extensor tendon,

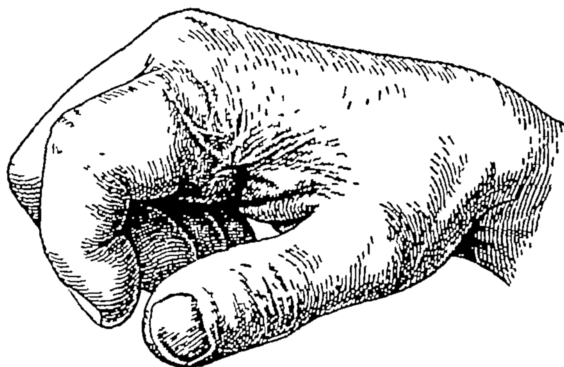


Fig 29 Late end-result of a wound of the metacarpo-phalangeal joint of the index finger A resection of the head of the metacarpal was done at the outset, and the skin and tendons were sutured at the same time The finger is in a good position and a little shortened Limited movement is possible at the resected joint and the other joints are normal

being tightly stretched over and adherent to the articular capsule, is also cut through when the joint is wounded The greatest danger is infection, and Case 2 reported in this book is a good illustration of this

Treatment is carried out under a general anæsthetic, and the procedure adopted depends on the wound

Linear wound, recent and clean cut one can suture the tendon and the skin after washing out the joint

Small irregular wounds (bite wounds) · excise all contused tissues, wash out the joint with ether, do not suture the capsule or the skin, for the danger of infection in bite wounds is particularly great (Mason (4) has, in a very important article, demonstrated the seriousness of these wounds) The finger is then immobilised on a plaster splint If arthritis develops, perform a resection of the joint forthwith

Large irregular wounds (moulding machines, circular saws) I believe that there is, in such cases, a twofold advantage in performing a resection of the metacarpal head at the very outset It forestalls any infection and, if the wound is recent, it allows for primary suture of the skin and of the capsule previously regularised The finger is then immobilised in plaster in the position of function

Fig 29 illustrates an excellent end-result of a primary resection · the metacarpo-phalangeal joint is solidly ankylosed, *but the second and third phalanges are freely movable in extension by the interossei* and in flexion by the flexor tendons Healing had been rapid and uneventful, for the operation had been performed only three hours after the injury The patient was

particularly grateful and returned to see me eighteen months after the injury, having recovered full functional capacity

Lesions of the Wrist Joint

Every single wound occurring in the region of the wrist joint must be carefully explored It is only by exploration that a lesion of the joint and its extent can be discovered

1 Sometimes the wound is purely cutaneous and exploration shows the joint to be intact Treat as a superficial wound

2 In other cases *the joint is opened* and to illustrate this I quote a case of my friend Cahen

CASE 32 Wound on the dorsal aspect of the wrist joint inflicted by a knife Exploration the joint was open The wound was left open aseptic dressing and immobilisation Complete healing It was useless and dangerous to close the wound

The foregoing treatment appears to be in contradiction with the generally accepted ideas (Leriche in Lecène and Leriche *Thérapeutique chirurgicale* t I p 461) that synovial tissues become more resistant when the joint is closed

As a matter of fact as Lenormant says primary suture of the joints *is never done except in the knee joint* In this joint the anatomy of the part is unique big bones a single and superficial joint space loose synovial tissue thin and resistant fibrous layers *the feasibility of excising all that is contused* in the different layers and the possibility of suture on account of the ample material available and on account of the strength of the latter The wrist joint is on the other hand completely the opposite it is tight it contains numerous small bones and many synovial pockets the synovial membrane is thin and scanty and the fibrous layers are without resistance Excision and suture under such anatomical handicaps are not possible the joint cavity can only be closed by suturing the skin and I have already stressed that the risks run by this method of closure are too great

Immobilisation is on the other hand absolutely essential it is maintained by a palmar splint in 60-degrees dorsal flexion

3 *The joint is open and there is fracture of the carpal bones* The great danger is infection The treatment to be adopted is the one generally recommended for comminuted articular fractures for the fracture of the small carpal bones is always

The *lesions* of the skin are sometimes minimal (cuts), sometimes severe (circular saws) (v Fig 29) The extensor tendon,

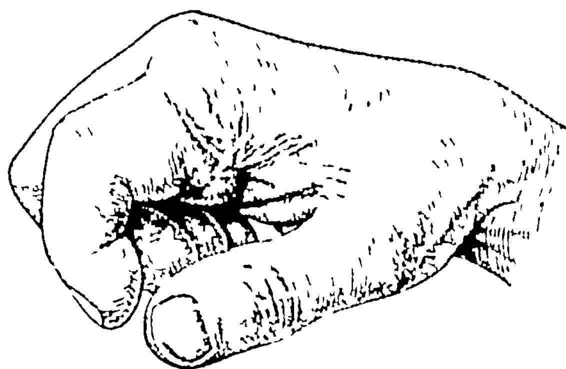


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comminuted. Open the wound, excise the edges and perform a resection before the onset of arthritis It is only by so doing that one can prevent this complication Here is an example of an articular wound in which this general rule was not applied

Case 33 A carter, aged 45, was bitten on the hand by his horse The wound was very *small* and situated on the ulnar side of the dorsal aspect of the wrist and at the level of the bases of the metacarpals There was a good deal of pain in the wrist joint X-ray showed an incomplete fracture of the lower end of the ulna and comminuted fractures of the capitate and triquetrum Four days later there was arthritis of the wrist with much swelling An urgent intervention was then carried out, the abscess was opened through a small dorsal incision and sera and vaccines were given Numerous incisions were performed during the following months, and finally a resection of the wrist joint was carried out The patient was seen again months later, his hand was deviated, without strength, without movements and useless The patient was, however, of very low mentality

It is evident that the initial mistake was in not exploring the small wound The seriousness of infections following bites is well known and this alone should have been an indication for exploration of the wound and immobilisation of the hand in plaster, particularly when the crushing of the tissues caused by teeth is taken into consideration

4 *The joint is open and infected* Two types of cases occur

There is an infected compound fracture (*v* Case 33) An immediate resection of the joint must be performed This is the only procedure that removes all the fragments likely to maintain infection, and that provides drainage

There is no fracture (a type of case seen after an infected punctured wound) Adequate drainage must be established by limiting the resection to the lunate and the wrist is then immobilised Here is an example

Case 34 Wound of the anatomical snuff box inflicted by a piece of glass It goes unrecognised The patient when first seen shows all the signs of an abscess of the hand J Quénu, the emergency surgeon, operates, he finds no pus in the tendon sheaths, retracts the tendons to one side and finds a swollen joint, he makes a small incision in the latter and pus pours out He then makes a dorsal incision and removes the lunate in order to provide drainage The end result is excellent

often surprised at operation by the size of these foreign bodies



Fig 30 Removal of a foreign body from underneath the nail.

No attempt must be made to pull on it by ordinary means. The foreign body must be completely exposed under local anaesthesia.

An *operation* is urgently and absolutely indicated It is useless to try to pull out the splinter it will only be partially removed, and the dangers of infection of the small sub ungual cavity are great

The technique is simple ring ' anaesthesia and a small tourniquet round the base of the finger A wedge shaped piece of nail covering the foreign body is now removed the base of the wedge is distal and its apex must be just proximal to the point of maximum *penetration of the foreign body* The foreign body is then easily removed and the resulting wound is cleaned and dressed This method avoids all possibility of infective complications

Foreign Bodies in the Hand and Fingers

Technique of Localisation A preliminary X ray is taken to show any opaque foreign bodies (*v* Fig 31) if present the



Fig 31 X ray showing a piece of glass which had been in the hand for several weeks.

CHAPTER V

FOREIGN BODIES IN THE HANDS

THE tolerance of the tissues of the hand varies widely according to whether the foreign body is metallic or, on the other hand, wood or bone Metallic foreign bodies are well tolerated and I have been unable to find records of a whitlow or abscess of the hand forming round a needle or metallic fragment The other foreign bodies such as splinters of wood are, on the other hand, always septic and are often the cause of a serious infection Metallic foreign bodies must, therefore, be removed if they are troublesome, which is often the case, and, moreover, on account of the psychological point of view Patients dislike the idea of having a needle in the hand and demand its removal Splinters of wood and pieces of dead bone must be removed as soon as possible, as they soon give rise to pain on account of the inflammation they cause

But these operations must be performed with the greatest care, with all possible aseptic precautions and according to the technical details to be described No operation on the hand or on the fingers is to be undertaken lightly, the next case is a sad example of that

CASE 35 An exploration for a needle in the thenar eminence was performed in the casualty department on April 14th, 1924 On April 30th a large abscess of the radial bursa was present *Débridement* of the wound, pus was seen coming from underneath the flexor retinaculum, the latter was sectioned and the thumb with its metacarpal were amputated Despite that, the suppuration continued and the forearm had to be amputated The patient weakened gradually and died on June 20th, 1924

Such cases are fortunately rare, but they illustrate the danger of performing operations, even though they may be small ones, without due consideration

Foreign Bodies under the Nail

The lodgement of splinters of wood, fragments of metals or pencils under the nail is of frequent occurrence, and one is

under an X ray screen The tourniquet is now removed hæmostasis secured and the wound stitched

Esmarch's bandage also has the advantage of facilitating the search for foreign bodies that are transparent to X rays (*e.g* splinters of wood) but the pain occasioned by these foreign bodies helps us to localise them roughly, although a thorough search can only be properly made in a bloodless field In such cases it is useless to suture the wound for it is always infected and in any case it soon heals

part is screened and a cutaneous mark is placed exactly superficial to the foreign body (A mark with a skin pencil or small pieces of lead fixed with strapping)[1]

The next most important step is to use an Esmarch bandage It is most unfortunate that the usefulness of this practical and classical tourniquet is so often forgotten The search for a needle in the hand is as easy in a bloodless field as it is difficult in a stream of blood even under radioscopic control The search is rapid, the tissues are not traumatised and there are no risks of infection

Esmarch's bandage must be used properly The hand is first raised, the rolling up must start at the fingers and continue to the forearm The bandage is tied at that level and the distal spiral turns are undone up to the wrist

Anæsthesia. The anæsthesia must be local. In addition to its simplicity and security when it is properly given, it has the tremendous advantage of distending the region where the needle is situated with a clear and transparent œdema, through which any dark foreign body is easily seen It must be given according to the rigorous technique described by Pauchet-Sourdat-Labat *The skin of the palm must never be pricked*, as it is much too painful to the patient The skin of the dorsal aspect is much less sensitive and the needle is introduced here and *pushed through the thickness of the hand to infiltrate the tissues of the palm* An intradermal wheal is also raised in the palm from the dorsum in order to facilitate the painless re-introduction of the needle for further injections The infiltration of the tissues must be extensive and not confined to the subcutaneous tissues The skin itself must be infiltrated until it becomes white, for, should the injection be confined to the subcutaneous tissues, the anæsthesia will be unsatisfactory

Operative Technique An incision is made at a right angle to the direction of the needle as marked on the skin A Kocher's forceps is placed on each edge of the wound to mark the level of crossing of the skin mark and the incision After incising the deep fascia, one sees the dark outline of the needle through the transparent tissues When there are several fragments, even small ones, they are easily seen and removed This is, of course, an impossibility when the tissues are bleeding even

[1] It is sometimes possible to locate foreign bodies that are transparent to X-rays by transilluminating the finger with a strong light

THE PAINFUL SYNDROME

Causalgia (Weir Mitchell)

Causalgia [1] is characterised by sensations of severe burning in the fingers or in the hand and by a typical appearance of the skin which is smooth bright and red (glossy skin) *The pains appear soon after the injury* and are made worse by heat and dryness which give rise to real crises hence the patients often cover their hands with wet cloths which they keep re wetting when these become dry

Causalgia is caused especially by wounds of the nerves that contain non myelinated fibres (ulnar and median nerves especially) but cases have been recorded after a simple injury to the palmar or digital branches of these nerves Leriche (2) in 1925 ventured the opinion that the disease might have its origin in the sympathetic nerves this opinion was rapidly taken up and is now generally recognised

Traumatic Diffuse Neuralgia

Leriche understands this explicit term to be the classical *ascending neuritis* but without it being a true neuritis since inflammatory signs are absent and since the cerebro-spinal nerves are not affected because the topography of the pain does not correspond to theirs This affection is much more frequent than the previous one and occurs mainly after small wounds of the fingers and hand (superficial burn purely cutaneous wound) even when there is no lesion of the small digital nerves

The clinical sequence is always the same *Some weeks after* some insignificant injury such as a prick of a finger or a cut tendon pains appear in the region of the wound to spread up the hand soon afterwards they then spread up the forearm and later up the arm In a few months the whole member is immobilised by this pain, which irradiates everywhere and which has features of pain of sympathetic nerve origin One is struck by the atrophy of the peripheral parts the fingers taper and the joints become stiff Finding relief nowhere these unfortunate individuals true Wandering Jews of pain travel from town to town always asking for another amputation in the hope perpetually deluded of a cure which never comes I have known one patient who had disarticulations first of a

[1] Gr [illegible] a burning

CHAPTER VI

TROPHIC AND PAINFUL SEQUELÆ

FROM time to time, surgeons are persecuted by the regular attendance of old patients who present painful symptoms, circulatory troubles, functional incapacities and vicious attitudes of limbs which are almost unaccountable and which are, alas! rebellious to every form of treatment. Let us be thankful to Leriche for having taken an interest, for many years now, in this problem and for the important papers which he and Fontaine have written on the subject. From this work, which is full of facts and references, we propose to extract some simple observations with their practical applications.

Definition. Leriche and Fontaine (1) give the following excellent definition for painful and trophic sequelæ: "Post-traumatic complications that are not, at the outset, accounted for by lesions caused directly by trauma or by scar tissue, *and the severity of which, as often as not, contrasts markedly with the insignificance of the initial trauma*, which could only have caused negligible anatomical lesions; one is, therefore, forced to admit the role of 'impaired function' in order to explain them."

Classification. This characteristic clinical feature and the fact that these complaints are all accompanied by vaso-motor disturbances allow us to include, in this syndrome, disorders which are, at first sight, somewhat different; they are:

Pains;
Stiffnesses and contractures;
The post-traumatic dorsal œdema of Secrétan;
Trophic and vaso-motor phenomena;
Post-traumatic osteoporosis.

The fact that many of these complications may co-exist in any particular case confirms their unity.

surgeon to get involved in psycho neurological discussions it is my experience that the patients who suffered from these lesions were nothing short of normality in their mental make up

HARD DORSAL POST-TRAUMATIC ŒDEMA

This affection described for the first time by Secrétan in 1901 is rare Personally I have never seen a case

It is seen after common injuries a labourer receives an injury to the dorsum of his hand a simple contusion very often without a wound but with swelling ecchymosis etc The X ray shows no bony lesion

A few hours later (Leriche) but more often a few days after the injury marked œdema of the dorsum of the hand appears The œdema is persistent, very painful and hard and does not pit on pressure *The swelling is limited to the back of the hand and does not involve the wrist or the fingers* In some cases it remains localised to one part of the dorsum for example the ulnar side

There is rapid and marked functional impotence the movements of the fingers becoming limited and painful The affected hand is warmer than the other and muscular atrophy spreads to all the muscles of the forearm and later to those of the arm Despite all this the arterial oscillations are not affected and a neurological examination is negative In some old standing cases a slight decalcification of the metacarpal bones has been observed. The œdema persists indefinitely the muscles get weaker and the joints become ankylosed The resulting incapacity is often assessed at 60–75 per cent It is therefore a syndrome with a very bad prognosis

Diagnosis The diagnosis consists essentially in eliminating the usual causes of œdema dorsal œdema accompanying a palmar infection or a subacute arthritis of the wrist infectious œdemas resulting from bite wounds or retained foreign bodies trophic œdema following lesions of the nerve trunks and finally one must not forget the possibility of a tuberculous arthritis of the wrist in which dorsal œdema is but one sign

Pathogenesis The pathology of this mysterious syndrome has had diverse interpretations Brouardel called it a hysterical manifestation Moreau called it an attenuated and chronic infection Patry and almost all other authors after him believe it to be due to *malingering* It is a well known fact that œdema

finger, then of a metacarpal at Lyon, of the wrist at Avignon, the forearm amputated at Marseilles, the elbow disarticulated at Grenoble and who eventually came to Strasbourg to ask me to disarticulate at his shoulder "

According to Leriche, these *diffuse pains* are also of sympathetic origin the topography of the pains is sympathetic (in one case there was even a Horner's syndrome), the pain is accompanied by vaso-motor phenomena, so much so that one patient had an incision made by his doctor, who thought he was dealing with a whitlow Finally, it is only operations on the sympathetic nerves that bring relief, operations on the peripheral nerves being always failures

Personally, I have only encountered two analogous cases The first was seen with Lecène and the symptoms had developed after a scald by an acid, which had caused a simple blister Several months later, the case had become so hopeless that my regretted teacher sent him to see Lhermitte This eminent neurologist diagnosed syringomyelia and kept him in his wards

The second case concerned a stump of the index finger Having discovered a particularly painful spot on pressure, I re-operated on him as a measure of precaution and explored the scar On the edge of the bone and intimately adherent to it was a neuroma of the digital nerve This was excised, the cut end of the nerve was ligated, and alcohol was injected into the nerve just above the ligature So far as I know, the patient has had no more pain

PHYSIOPATHIC CONTRACTURES (Babinsky and Froment)

I have seen only one case presenting this syndrome The deformity cannot be explained by the normal muscular or nervous physiology The tendons retain their movements although very limited, stiffness is marked but does not end in ankylosis, and there are well-marked trophic changes In other patients with nervous lesions, I have seen stiffness and contractures that could not be accounted for by the injury, these lesions will be dealt with in the second volume of this book, for they are only of surgical interest

Left alone, physiopathic contractures become absolute and incurable These lesions are very similar to what used to be called hysterical contractures, and although it is not for a

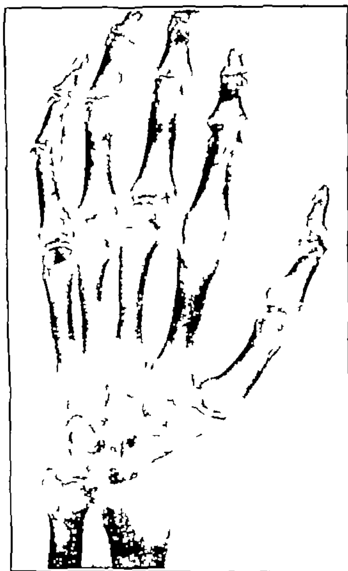


Fig 3 Osteoporosis following upon a small wound of the thumb It had appeared in less than two months

Note that all the joints are affected and that the second metacarpo-phalangeal joint is destroyed The elbow and shoulder joints are equally involved in the process of local fixation Such lesions precluded return to normal and treatment by novocaine infiltration led to a slight improvement only

[T face p 98

is easily caused either by constriction (its upper limit is then sharp), or by prolonged beating of the dorsal region with a lead spoon The appearance of this syndrome since the passing of the Workmen's Compensation Act in different countries and the incurable nature of the affection are in favour of this *generally accepted theory*

Leriche, however, believes in an organic cause He bases his opinion on the fact that some cases have occurred in non-insured individuals, on the good results of sympathetic operations and on the influence of the sympathetic nerves in the production of experimental œdema He has produced a *trophic œdema by reflex sympathetic vaso-dilatation*, the reflex having its origin in the contused region

PAINFUL OSTEOPOROSIS (Sudeck, 1900)

This affection is characterised by pains, swelling and a typical X-ray picture of the bones of the hand

The pains come on in a variable time after the injury, they affect other regions besides the traumatised zone, they are felt in the neighbouring joints and are not relieved by immobilisation in plaster They are sometimes severe and persistent

The hand is swollen, warm and looks stiff Leriche and Fontaine (Thesis of Tuefferd (3)) lay great stress on the vasomotor phenomena registered by the Pachon Sphygmomanometer These phenomena are observed in every case with a surprising regularity Compared with the opposite limb, they show an increase in the amplitude of the oscillations which, once the disease is established, tend to get less and later to *fall below normal* in the old cases

The *X-ray picture* is characteristic The outline of the bones is at first very distinct the bones have a fine edge, the covering cartilage contrasting sharply with the subjacent layers of bone that are in the process of decalcification The diaphyses are involved secondarily The first signs are seen in the bones of the carpus, which appear mottled and striped, everywhere one sees alternating clear and dark spots

The absorption of bone continuing, the X-ray soon shows a dull, fuzzy and homogeneous picture which gives the impression, particularly at the level of the carpus, of an X-ray picture that is out of focus or of an intense tuberculous decalcification, it

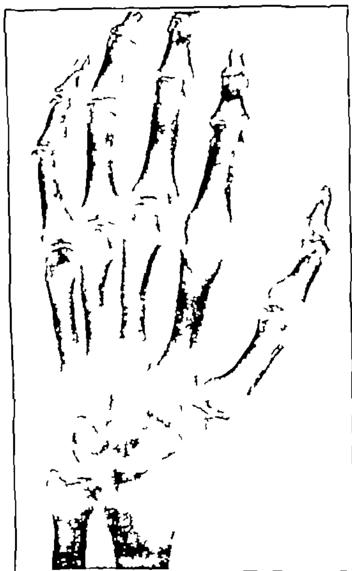


Fig 3. **Osteoporosis following upon a small wound of the thumb It had appeared in less than two months.**

Note that all the joints are affected and that the second metacarpo-phalangeal joint is destroyed. The elbow and shoulder joints are equally involved in the process of decalcification. Such lesions [illegible] return to normal and treatment by novocaine infiltration led to a slight improvement only.

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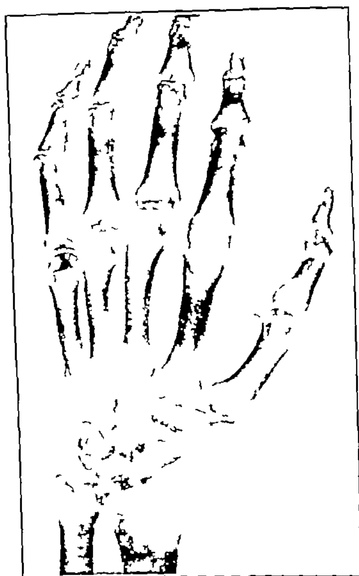


Fig 3 Osteoporosis following upon a small wound of the thumb It had appeared in less than two months.

Note that all the joints are affected and that the second metacarpo-phalangeal joint is least involved The elbow and shoulder joints are equally involved in the process of decalcification Such lesions precluded return to normal and treatment by novocaine infiltration led to a slight improvement only

is at this stage that the differential diagnosis from the latter disease may be difficult

Prognosis The prognosis is gloomy The disease may come on after insignificant lesions a sprain of a finger a blow on a phalanx or a sprain of the wrist (there were 12 such cases out of 27 reported by Tuefferd in his thesis) A spontaneous cure is possible particularly in young subjects but in the aged in whom the disease is most often seen the evolution is towards distortion of the bones and ankylosis of the articular surfaces When ankylosis occurs the pains disappear (Leriche)

Pathogenesis Since Südeck s description the bony atrophy has been considered to be due to inactivity of the bones following upon prolonged immobilisation Böhler reiterates this theory and believes that it is possible to prevent osteoporosis by correctly immobilising the broken bones while allowing at the same time movements of all the other joints This theory is unquestionable but it is equally obvious that post-traumatic osteoporosis is a totally different lesion from simple bony *atrophy due to inactivity*

As a matter of fact it does not always occur after fractures sprains and simple contusions have been the cause of it It is a painful disease and—this is an important feature—it is accompanied by vaso motor troubles All this invokes a sympathetic influence which Leriche has well shown According to him it is a case of vaso motor disturbances released by a painful trauma of which the *sprain* is the commonest type (4) When fractures are badly reduced the joints are sprained and suffer in consequence and it is a painful reflex starting at the joint and terminating in the bone that precipitates decalcification by vaso-dilatation The frequent good results of early novo caine injections which cut the reflex arc at its origin, show that this theory is verifiable in a great number of cases

TROPHIC AND VASO MOTOR DISTURBANCES

These alone are of no great importance they are really ancillary phenomena

The nails lengthen and sometimes bend back the skin becomes moist the hairs grow quickly and a glossy skin usually accompanies the painful symptoms

Cyanosis is frequent and is either localised to the region of the cicatrix or diffused over the whole hand When cold

sensations appear, the disease might be called *post-traumatic acrocyanosis* (Leriche)

Treatment

" The origin of these syndromes being solely vaso-motor, the curative treatment can only be an attack on the vaso-motor nerves that is destined to cut abnormal vascular reflexes, which, by combining into a vicious circle, finally end up in the pathological syndromes already mentioned " (Leriche and Fontaine)

Methods. Two methods permit this action

Those which cut the reflex arc at its origin ,
Those which cause hyperæmia

Methods Cutting the Reflex Arc

Local Anæsthetic Infiltrations (Novocaine) This method of treatment was first started in 1930 by Leriche (5) as a result of his work on sprains A sprain, according to him, is not accompanied by anatomical lesions in the majority of cases , it is purely functional in origin and is due to the sudden vasodilatation of the vessels of the part this reflex phenomenon is started by the pain and by nothing else If this hypothesis is true, it would suffice to abolish the pain to abolish the reflex, and, with it, the characteristic swelling and ecchymosis of sprains It is easy enough to anæsthetise the painful ligaments with novocaine, and in a great proportion of cases this early infiltration prevents the onset of the signs of sprains

Since then, Leriche has had his attention fixed on vasomotor reflexes and their origin from painful areas, and he has progressively adopted novocaine infiltrations for a whole series of lesions

Novocaine, 1 per cent , or percaine, 1/1,000, is injected in quantities sufficient to infiltrate the painful joint structures As soon as the anæsthetic is acting the functional syndrome improves, but soon reappears (at the end of two hours on the first day) The injections have, therefore, to be repeated daily, and generally the duration of the anæsthesia increases progressively

" In obstinate cases we have given more than thirty infiltrations before getting a lasting functional cure but the

patient and the surgeon must have courage to persist with it (Leriche and Fontaine)

Section of the Digital Nerves Section of the digital nerves was advocated as soon as it was thought that the disease was due to ascending neuritis originating from a peripheral lesion and by giving rise to a permanent anæsthesia it acts equally well as an infiltration of local anæsthesia by cutting the reflex arc at its source of origin. Sicard believed in injecting alcohol into the nerves rather than cutting them.

Methods causing Vaso-dilatation

Chemical Substances Acetyl-choline (Fischer) appears to be very useful and is easy to administer as soon as the functional disturbance is suspected

Physical Agents Heliotherapy Bier's constricting bandage and radiotherapy have all been advocated and been given by different techniques

Surgery Surgical interventions are essentially carried out on the sympathetic nerves either a peri-arterial sympathectomy or a sympathectomy of the ganglia or of the rami communicantes

Peri-arterial Sympathectomy Peri arterial sympathectomies must be performed at a very high level the axillary region being the lowest level at which it should be done for otherwise it is useless

Ganglionic or Rami Sympathectomy They result in a vaso dilatation that is more marked and of longer duration The operation consists either in cutting the rami communicantes or in ablating the stellate or the second thoracic sympathetic ganglion Before performing those operations however it is a wise precaution to infiltrate a local anæsthetic around the stellate ganglion[1] The object of this is to cause a temporary paralysis of the sympathetic nerves which demonstrates whether or not there is improvement in the lesions, if there is the ganglion may be removed and if there is not it is better to abstain

[1] Fontaine *Technique of anæsthetising the stellate ganglion* A point is chosen on the middle of the clavicle, the needle is pushed in there and directed towards the carotid tubercle and is then made to slide below and medial to it; 10 c c of 1 per cent novocaine is then injected. Proof that the ganglion is anæsthetised is given by the Claude Bernard Horner syndrome and a homolateral vaso-dilatation

Indications and Results of Treatment

The Painful Syndromes

Causalgia. As it appears rapidly, one can combine a local infiltration with an infiltration of the digital nerves. Several infiltrations are required as a rule; if they are insufficient, one has recourse to ganglionic infiltration.

"Never," says Leriche, "have we had to operate for causalgia resulting from lesions dealt with in this book." But one must have the necessary patience to continue anæsthetic infiltrations for as long as is necessary.

Diffuse Neuralgia. *If there is a definite painful point of origin* which corresponds to a cicatrix, it is absolutely necessary to start by excising the scar, to expose the corresponding digital nerve, to tie it, to inject alcohol above the ligature and then to cut it below the ligature. The wound is then stitched or grafted immediately, depending on the loss of skin.

If there is no definite point where pressure causes pain, one may start by making injections of novocaine into the painful region. If this fails, one must not think of performing a peri-arterial sympathectomy, but rather a ganglionectomy. Some lasting cures have been reported (Cavazanni, by resection of the middle and inferior cervical ganglia; Leriche, Wertheimer (6), Bonniot (7), by inferior cervical ramisection; and Gino Pieri (8) by stellectomy).

But these good results are not the rule; Leriche and Fontaine record two failures and believe that, in similar cases, one must remove the *second thoracic ganglion* rather than the first. Radicotomy and cordotomy have, on the other hand, no place in the treatment of these conditions.

Physiopathic Contractures

The therapy is similar: novocaine infiltration of the scar and its excision, then, in case of failure, stellectomy. Leriche and Fontaine quote the case of a young man who had had a left stellectomy done for stiffness of the left middle finger, which had followed an injury without fracture. "He recovered the movements of his finger on the night of the operation and the result was permanent at the end of three and a half years."

Post-traumatic Dorsal Œdema

In the mild varieties, physiotherapy is indicated: hot baths and moist dressings. Massage must be absolutely proscribed

at all stages of the disease (Secrétan and Patry) Bouchard believes that hot air baths (50°–60° C) are very beneficial In another connection Lecène used to insist from a prophylactic point of view on the necessity of preventing these patients from putting on slings from which their hand hangs over the edge During the war of 1914–18 he had seen the prolonged use of such slings give rise to chronic œdema and complete functional incapacity

In the severe types of cases diverse operations have been performed Schlichting has removed without benefit the shaft of the third metacarpal bone because it gave a dark shadow on X ray photographs Brouardel quotes three amputated cases with *recurrence of œdema on the flaps* of the stump

The sympathectomies appear to be the only form of treatment that have given excellent results in the hands of Leriche (sympathectomies on the brachial and subclavian arteries and ramisections in obstinate cases) The results in the hands of Bianchetti have however been less constant and less complete

If after several months of fruitless physiotherapy the patient refuses operation, one must discharge him and assess the degree of permanent incapacity resulting from his wound while reckoning above all things the disability of the joints Should a cure occur at a later date it will be easy to revise the indemnity

Operations on the sympathetic nerves work wonders according to Leriche and Fontaine They describe 6 cases *which were treated successfully 4 by high peri axillary* sympathectomy 1 by peri subclavian sympathectomy and 1 by inferior cervical ramisection Wertheimer also describes a few cases with equally good results

As the course of the disease is hopeless and as amputations have had to be performed for certain cases one must try everything and one must not be discouraged to try another operation if a previous one has failed

Osteoporosis

It is difficult to deal separately with hard œdema and osteoporosis for these two lesions are often associated and the treatment is therefore similar Leriche and Fontaine report 11 cases treated by

Peri-subclavian sympathectomy .	1
Peri-axillary sympathectomy . .	5
Unilateral stellectomy	3
Combined stellectomy and peri-axillary sympathectomy	2

The functional symptoms and the swelling disappeared rapidly in a few days, but recalcification was much slower

Trophic and Vaso-motor Troubles

These complaints are minimal when they occur alone (which is rare), and they are best treated by physical agents If they persist and become troublesome, it is easy then to perform a peri-axillary sympathectomy

In short, out of this long discussion of cases, which are fortunately rare, it seems possible to make the following statement "novocaine infiltrations done at the outset, as soon as the first suspicious signs of painful or trophic complications appear, and continued for as long as is necessary, are capable of preventing the development of these complications, which when left to themselves may well lead to the permanent invalidism of workmen who are victims of small injuries that should have been absolutely benign" (Leriche and Fontaine)

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CHAPTER VII

WOUNDS OF THE HANDS AND FINGERS SOCIAL PROBLEM

THE surgery of the hand and of the fingers has this in particular (1) A great proportion of it is not done by trained surgeons to whom in any case it holds little interest as a general rule (2) Its maximum incidence is in the working classes and it accounts for a considerable percentage of works accidents although this varies according to the different trades the majority of wounds of the hand are therefore protected by their insurance companies (3) The whole future of the patient is dependent *on the first operation*, which ought to be done as soon as possible A crush of the thumb operated on at the outset heals in three weeks badly treated it will drag on for six months and cause permanent disability

The frequency of these small lesions the gravity sometimes vital which they can present the long periods of incapacity from work which they lead to the frequent difficulties of treatment the training skill and patience which they require of those who treat them all set the following problem (a veritable social problem because it demands surgical treatment for a community) to decide who is to do the early operation—wrongly called *first aid*—in order to give the best guarantee to the patient

The patients can indeed be treated

By their family doctor

At the ambulance room which is either attached to a large factory or which is directed by a medical man specialising in works accidents

By a trained surgeon either at hospital or at a private clinic

Let us consider as objectively as possible the possibilities of each one of the above mentioned and the type of treatment that they can give to the injured

The Family Doctor Every qualified practitioner has the absolute right of practising surgery. Further, the law of 1898 allows the patient full liberty of action in choosing his medical man so that the great majority of accidents are first seen by a practitioner Now the latter can belong to one of the following classes from our point of view

The *family physician*, whose mentality type of practice and want of time do not allow him to treat wounds the locality of his practice in the big centres allows him to send these patients straight to the surgeon

The *general practitioner* the exigencies of whose practice or his remoteness from a surgeon force him to give personal attention to these lesions which the general public judge as slight and for which they would refuse early recourse to a specialist It is often the case that these practitioners have a liking and possess no small degree of skill for this type of surgery They are therefore, perfectly capable of giving excellent treatment but their duty lies in equipping themselves in acquiring the technical knowledge, and in knowing the limits of their capabilities Moreover, success will bring them further cases, which will in their turn augment their experience

The Ambulance Room The dispensary surgeon is at an advantage in having facilities and equipment superior to those possessed by the practitioner, he has a nurse and is always assured of a sufficient number of cases (whether he belongs to a large factory or is situated in the midst of an industrial centre) The impossibility of in-patient treatment however characterises this type of practice

The ambulance room has many advantages it *affords facilities for good* work and the medical man in charge can acquire considerable experience I know some who are very good. Unfortunately it often happens that the medical man is not attached to the place he only spends one or two hours there and the nurse is on duty for the rest of the time The dressing then becomes the essential feature of the treatment wounds of benign appearance are simply dressed and those that look severe are sent into hospital · in both types of cases the dispensary is not only useless but can even be very dangerous because it is based on a false concept, the priority of dressings I have visited in a large motor car factory, a model ambulance room, so "model" that it has

been copied by a railway company The decoration is on a grandiose scale and ceramic throughout and only coloured lamps and notices are used throughout The tables are ultra modern the essential feature of which is a battery of nickel pumps which spurt out various antiseptic liquids of different concentrations and which allow (theoretically) the nurse to dress the wounds without touching anything with her fingers

This system works to everybody s satisfaction and is a step in the right direction if one admits that the surgical exploration of wounds has not to be systematically performed and if one also admits that dressings must be everlastingly renewed by anybody

But from the surgical point of view such a conception is inadmissible to bring back the treatment of wounds of the hand to pumps and ceramic decorations to lay down as a principle that an ambulance room which is expensively furnished expensive in upkeep (for the director is very well paid) and useless in the case of a more or less severe wound of the hand may be *a conception of engineers but certainly not of doctors and more particularly of surgeons* On the contrary if it is admitted as we wish it to be that to give adequate treatment to a wound of the fingers a well-conducted and early operation followed by rest and immobilisation of the part and infrequent dressings is necessary then such organisations are unwarrantable and do more harm than good

I have only spoken of well managed ambulance rooms the object of which is to give treatment to injured workmen It is better to remain silent on the working (known to everyone) of the small ones where the injured workman comes to have dressings done once or several times a day and where the practitioner calls from time to time with his hat on, to sign certificates

The Surgeon The surgeon who sees the patient in hospital has the best guarantees of competence of material facilities and assistance Unfortunately he is not always interested in this type of surgery L used to state that in the case of cut flexor tendons it was better to amputate the finger immediately for repair was doomed to failure I know of a case of a young man whose hand had been perforated from side to side by a rifle shot fired point blank, an excellent surgeon immediately performed a disarticulation of the wrist

and yet the thumb, the second and fifth fingers were nearly intact.[1] The surgeon has a tendency to be *non-conservative* and to perform rapid operations (generally an amputation). The subsequent wound will be dressed by a nurse, and the period of incapacity will be reduced. This is equally in the interest of the insurance company, which pays more in compensation during prolonged conservative treatment than it does in final settlement of a permanent partial incapacity resulting from an amputation, the sum for which is generously given but rarely much in amount. Besides, many patients are less anxious to have conservative treatment carried out to its utmost; they also desire a reduced period of incapacity, a pension rapidly settled and a return to work as soon as possible.

Yet, conservative treatment is possible; it is the ideal for which we ought to strive, and it is the reason for the existence of our profession. It is so much more appropriate in these cases because the hand is a vital part of the working man, and because the compensation is paid by a ruthless third party—the insurance company. To adopt conservative treatment, however, requires a lot of time and is full of difficulties. For example, Böhler estimates the time required for the initial operation of a compound fracture of the finger to be two to three hours. Objection has been raised against the disproportion between the length of time spent and the object in view, to which he answers: "Is it more important to save the hand of a young workman than to operate for an extensive cancer in an old man? What difference is it to the patient if he is immobilised for six months, whether it is for a compound fracture of the femur or for a crush of the thumb?"

Personally, I am perfectly certain that the busiest of surgeons, wounded in a motor car accident, would think it perfectly normal for somebody to spend three hours in treating his wounds. The case is beyond argument; the ideal to be aimed at is to save as much as possible, and to sacrifice at the outset only what must be sacrificed; but this differentiation can only be made by somebody of experience and only at the first operation. We always fall back on the importance of the first operation.

Conclusion

Since one of the current anxieties seems to be to organise I shall not hesitate to say that the treatment of wounds of the hands ought to be organised Böhler writes 'The first treatment (on which the course of the lesion will depend) must be so organised that the wound can be treated as soon as possible during the day or during the night by a practitioner who is experienced in this type of surgery Further he who has operated on and sutured the wound must be in a position to do the after treatment in order that he might take full responsibility for the case This results in creating clinics for traumatic surgery such as the one directed by Böhler himself in Vienna, that of Judino in Moscow and those which have been organised in almost all the American cities It is only such clinics that can give the necessary training facilities in this type of surgery to practitioners who will have to treat the majority of these cases a training which necessarily requires as much practical work as theoretical knowledge In Paris extraordinary courses are given on the subject both at the University and at various clinics but they are only theoretical In the out patient departments of the large hospitals the student can acquire some personal experience in the treatment of small lesions of the hand but it is rare for the teacher to guide him in this

I am afraid therefore that things will remain as they are for a long time yet The organisation of clinics similar to that of Böhler would run counter to the practice (if not the interests) of the faculty of medicine of hospital surgeons and insurance practitioners and finally to the sacrosanct dogma of free choice There is therefore nothing to hope for

An improvement would certainly occur if the mode of remuneration were altered if the reverse of paying little for an operation and comparatively more for dressings were started it might be possible to obtain a thorough primary treatment and infrequent dressings afterwards There is nothing to hope for from that angle either

The only hope left is in this work I feel sure that the majority of practitioners are only too willing to treat wounds of the hand and that the majority of patients ask for the best possible care My book is their only guide for this type of work and this is why I have spared no effort in making myself clear and have not hesitated in going into the smallest details

I hope the advice given will be of some help to those unknown friends who happen to read these lines, and I hope, further, that they will not blame me if they encounter early failures, which must of necessity occur in lesions that are so difficult to treat

PART TWO

INFECTIONS OF THE HAND

INTRODUCTION

A WHITLOW is always serious and it is useless to insist on this fact It is serious in itself on account of the long time required for its cure it is particularly serious on account of the local or general complications it may give rise to (1) A general infection may kill the patient an abscess of the hand only too often cripples it

The surgeon is nearly helpless in preventing septicæmia which is as a matter of fact more often due to the virulence of the infecting organism and the poor resistance of the patient than to the local extension of the whitlow In the previous history of cases of peri nephric abscesses how often does one find a simple paronychia (A. Iselin) ? Similarly a large abscess of the axillary glands may develop on its own after a complete cure of the causative whitlow In the extreme case viz a small punctured wound there is not even a whitlow but a septicæmia from the very commencement

On the contrary surgery is all powerful against the spread of a whitlow A whitlow if properly treated ought not to give rise to complications and ought not to spread The proper treatment of a whitlow consists in opening the focus of infection largely and in exposing the purulent tracts leading from it To know where the pus is situated and to know where it is going to spread to is to know the whole surgery of suppuration. Unfortunately whitlows are still often badly treated. One has only to look up the registers of any Paris hospital to convince oneself of this fact The average duration of treat ment is four to six weeks many take one and a half to two months and have sinuses and almost all are incised on two or three occasions So that a whitlow becomes a constant dread to surgeons who are exposed to small punctures particularly when operating on septic cases The list of those victims would be too long to give here but we cannot help thinking of two old colleagues one Deroche who died in 1926 as a result

of an abscess of the hand, the other W. , a surgeon on the outskirts of Paris, who, on account of his energy, can still operate despite the state of his left hand, which was seriously crippled by an abscess of the bursæ in 1925. Such occurrences ought to be very rare and can only be accounted for by the extraordinary virulence of the inoculated micro-organisms A whitlow which is properly opened and well treated ought to heal rapidly and naturally Since we have been treating whitlows according to the modern techniques, I have practically never seen any complications, they have all been cured by a single incision, and the average duration of the dressings has been reduced to three weeks

This progress is mainly due to a better knowledge of the pathological anatomy of the lesions, and not to the adoption of any new form of treatment It is simply due to the fact that, having a better knowledge of the locality and the lines of spread of the pus, we have been able to adopt new incisions which open the collection at its optimum point, and which drain it as well as possible But it is obvious that, in order to make an adequate incision, one must have an *anatomical knowledge* of the locality of the infection and recognise its variety by a *clinical examination* We have been compelled to elaborate the classical ideas which have, after all, only been slightly modified since Chassaignac, Dechambre, and the theses of Chevalley and d'E Schwartz We are not trying to suggest that these lesions fall into a narrow speciality to be practised by a few surgeons, the procedures to be described can be practised by any practitioner who may feel himself compelled to study carefully the reasons and the technique

We shall first describe the general principles that govern the treatment of all varieties of infections of the hand In a second chapter we shall describe the normal anatomy of the cellular spaces of the hand, spaces in which all types of infection originate and spread, for it is only by a proper knowledge of these spaces that the progress just stated has been made This chapter ought to be studied, pondered over and assimilated, for although its contents are very simple, they concern a very different anatomy from that usually given in the classical text-books Finally, we shall deal successively with the anatomical characteristics, clinical course and treatment of every variety of whitlow and infections of the hand

My first book written in 1927 had been greatly influenced by the remarkable studies of Professor Allan B Kanavel (2) and of Klapp and Beck (3) The number of cases seen between 1927 and 1930 and particularly the 217 cases collected in 1930 in the out patient department of the Saint-Louis Hospital have made us realise that those authors had only dealt with the general aspect of the problem many problems had still to be clarified many gaps to be filled in so much so that improvements were possible I have thus been led to describe a new variety of subcutaneous whitlow (for as far as we can find from the literature it seems to have escaped the attention of all authors) *the whitlow of the second or middle segment of the finger* I have also been compelled to modify the incisions for whitlows of the pulp and particularly those for tenosynovitis and finally to rearrange completely the important chapter on Infections and abscesses of the cellular spaces of the hand

The pathological anatomy of these lesions is therefore the foundation of the whole problem hence we have made an effort to give it a fuller description than that given by the classical text-books Here is the classification that we have adopted it is easy to understand and to remember for *each variety has its own clinical features and its own particular incision*

Whitlows

Superficial (in one of the layers of the skin, the nail being considered as part of the epidermis)

- Phlyctenoid whitlow
- Peri ungual whitlow (paronychia)
- Sub-ungual whitlow
- Anthracoid whitlow (furuncle of the finger)
- Acute spreading infections
- Gangrenous whitlow
- Erysipeloid

Deep subcutaneous

- In the cellular spaces cellulitis
  - Whitlow of the pulp (third phalanx)
  - Whitlow of the second phalanx (middle segment)
  - Whitlow of the first phalanx (basal segment)
- In the tendon sheaths tenosynovitis
  - Digital tenosynovitis of the second *third and fourth* fingers (the others being abscesses of the hand

rather than whitlows of the fingers, on account of their communication with the carpal tendon sheaths)

Osteomyelitis of the Phalanges : they are usually secondary and very exceptionally of primary origin They occur mainly in the terminal phalanx and very rarely in the proximal phalanges

Arthritis : they are also primary or secondary

Abscesses of the Hand

Superficial phlyctenoids (septic corns)

Superficial anthracoids, mainly on the dorsum of the hand

Deep sub-aponeurotic

In the cellular spaces thenar, hypothenar, middle palmar spaces (pre-tendinous, retro-tendinous, commissural) and dorsal

In the tendon sheaths radial and ulnar

It is to be hoped that many surgeons will be convinced by our arguments and that the adoption of the techniques advocated in this book will give them as good results as those obtained in the clinics of Professor Moure and Dr Robert Monod, not only by us, but also by the most modest collaborators who have been willing to follow the lines of treatment described further on in this book

Five years have passed since I wrote those lines and proposed this classification I have seen very many patients since and none have invalidated what has been written So, in the present edition, the part dealing with "Infections" is very little altered Three new chapters have been added, *Acute spreading infections*, *Gangrenous whitlows* and *Erysipeloid*, but the chapter dealing with abscesses of the cellular spaces has not been altered at all the presentation of tenosynovitis alone has been modified, for its substance is the same

REFERENCES

1 AUVRAY "Plegmon de la main Ostéomyélite aigue métastatique du corps du fémur Fracture spontanée dans le foyer d'ostéomyélite"— GREGOIRE, "Ostéomyélite des deux humérus et du fémur, chez un homme de cinquante ans, a la suite d'un panaris, mort au bout de six mois par septicémie" (*Bull Mém Soc Chir*, p 593, 1928)

2 A B KANAVEL "Infections of the hand," 1 vol, 7th edition, Lea and Febiger, edit, 1936

3 R KLAPP et H BECK "Das Panaritium," 1 vol, Hirzel, edit, Leipzig, 1923

CHAPTER VIII

GENERAL PRINCIPLES OF TREATMENT

Before describing the incisions resulting from anatomical researches which will be given later we shall deal with the general principles of treatment

The Treatment must be early, for it is only at the outset that infections of the cellular spaces and tendon sheaths are well localised Neglected, they quickly spread and cause an infection of the whole hand with a hopeless prognosis

But the Diagnosis must be certain it is better if in doubt about the localisation of the pus to wait a few hours or a few days for an incision made too early badly performed or carried out haphazardly would risk infecting the cellular spaces or a tendon sheath that are not already affected On the contrary one must recognise the presence of pus and operate as soon as possible the surgeon must know where to look for pus

The Necessity for a Perfect Anaesthesia and a Bloodless Field. The opening of a whitlow such as we understand it is totally different from the classical thrust that the practitioner gives under ethyl chloride anaesthesia on a corner of a table It is a genuine small operation in which one must expose the focus of suppuration, excise all the necrotic tissues explore the possible tracts of spread and which lasts several minutes In order that it might be properly carried out one must work calmly on a patient who is perfectly anaesthetised and one must have a clear field of vision, *i e* under the protection of a tourniquet These two precautions appear obvious and yet they are very seldom observed as we can always verify by the patients who have been already operated on elsewhere and who come to see us in hospital or in private *The great majority of complicated cases that we have had to treat had been incised elsewhere* These incisions were in some cases insufficient and in others too extensive having spread the infection and irreparably injured some important structure of the finger but they all had one common characteristic the

rather than whitlows of the fingers, on account of their communication with the carpal tendon sheaths)

Osteomyelitis of the Phalanges . they are usually secondary and very exceptionally of primary origin. They occur mainly in the terminal phalanx and very rarely in the proximal phalanges

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Finally, the objection raised against post-operative pain is worthless Post-operative pain occurs after all general anæsthetics besides, the latter are not without danger and are practicable only in surgical clinics It is a grossly exaggerated objection, for none of our patients has ever complained of intolerable pain after operation

General Anæsthesia Local anæsthesia is impracticable in whitlows of the proximal phalanx, in tenosynovitis and in all varieties of abscesses of the hand One must not think of injecting a local anæsthetic near foci of suppuration, which are often difficult to localise Regional intravascular anæsthesia, recently studied by my friend P Cahen, cannot be employed in infections Finally, anæsthesia of the nerve trunks at the elbow or higher up is not yet a practical proposition General anæsthesia is therefore the only expedient The necessity of using a general anæsthetic is a source of great worry to isolated practitioners but if one considers the dangers of infections of the hand and the difficulty of carrying out proper treatment it becomes obvious that such cases do not fall within the province of a practitioner but rather within that of the experienced surgeon. In any case decentralisation is such at present in France that a trained surgeon should be available anywhere

Many doctors have told me that patients were not very keen to be anæsthetised my impression has been the reverse, the first word of every patient being above all doctor, give me a good anæsthetic Everything is therefore in favour of our two propositions perfect anæsthesia bloodless field and our regretted teacher Lecène always said 'A decisive progress will be made on the day when everyone is convinced that a whitlow must be operated on only under a perfect anæsthesia

The anæsthetic of choice in such cases is *Evipan* Credit is due to Dr Robert Monod for having introduced this wonderful drug in France and for having made a systematic study of it In his clinic it has been used regularly since 1933 without the occurrence of any accident or even the slightest alarm

Like all anæsthetics it must be given according to a rigorous technique Evipan does not economise an assistant for the patient must be watched and his jaw lifted until he recovers The technique employed in Monod's clinic is as follows An intravenous injection of 3 c c of evipan is given slowly over

painful memory of the patient Some of these cases had had a local application of ethyl chloride , others had had novocaine "rings," doubtless insufficient, or had been operated on before the onset of anæsthesia , finally, some patients had not been anæsthetised at all I cannot help shivering when I think of a pregnant woman with an abscess of the ulnar bursa, on whom a practitioner had performed a 2-cm. incision in the palm of the hand without an anæsthetic (and had cut the flexor tendon of the little finger) And yet we possess a perfect method of anæsthesia in the "ring" of Reclus , it can be used in all whitlows that do not affect the basal part of the finger, namely, those of the pulp and of the second phalanx All the other whitlows, whether they are in the cellular spaces or in the tendon sheaths, must be operated on under general anæsthesia, as they call for one or more incisions in the hand

"Ring" anæsthesia is a simple technical procedure, and it has already been described on p 13

Objections raised against "Ring" Anæsthesia It has been blamed as being useless, as dangerous and as a cause of pain two hours after the operation, pain which "is even worse than that caused by the incision" Those who say it is useless are partisans of an operation without any anæsthesia , their number and their practice will, doubtless, shrink Our teacher, Professor Archibald of Montreal, has told us of having seen for the first time in 1900, at a German congress of surgery, the demonstration of "ring" anæsthesia Czerny, then an old man, gave vent to all the scorn he could muster for a ridiculous and complicated practice and said that, in his clinic at Heidelberg, they did not make such a fuss with a scalpel, "well sharpened, the best anæsthetic," and with a single thrust made by surprise, the whitlow was incised and nobody ever complained

The most dreaded danger is subsequent gangrene of the finger , this complication was discussed at the *Société de Chirurgie* of Paris (1), and this excellent type of anæsthesia became strongly suspect I was able to report, during the debate, 122 cases done in 1930 without the slightest incident We have, on the other hand, observed 3 cases of *spontaneous gangrene of the fingers* following upon an infection and in which "ring" anæsthesia had not been used I must add that we have always used novocaine without the addition of adrenaline (Moure)

either corrugated (Delbet) or flat and cut from cuffs of old gloves (Kanavel) Their width should be 5–7 mm

Drains must not be used in irregular cavities such as those which result from the evacuation of a cellulitis of the pulp or of the hand for brisk hæmorrhage always occurs a small or large gauze wick according to the size of the cavity is all that is required It has the advantage of keeping the edges of the wound open

In short rubber drains and strips are indicated when there are communicating incisions (counter incisions) Gauze wicks are preferable when there is only one incision for they do not get displaced and they drain the suppurating cavity

As a rule drains must not be left in too long and should be removed as soon as the inflammatory signs (œdema and lymphangitis) have disappeared One must not simply wait for the end of suppuration for being foreign bodies they maintain it Gauze wicks must be left to fall out spontaneously they are detached by the pus and are usually extruded between the third and fifth day

Some German authors drain with a metal retractor which is held open by an elastic band this must be very painful and is only useful because their incisions are badly placed

DRESSINGS

It pains me to see dressings badly performed a practice which indicates a habitual lack of appreciation of the exact significance of an act which is elementary but which is generally misunderstood

The sole purpose of a dressing is to *protect* the wound from external contamination (in the case of wounds of the hand and of the fingers it also immobilises) *It is not a therapeutic agent but a protective one* Its role is to absorb the secretions of the wound and to prevent them from soaking through for when that occurs the dressing is no longer a protection this should be obvious to anybody

The dressing requires four components swabs or compresses absorbent cotton wool impermeable cotton wool (carded [illegible] wool) and bandages In addition it is the rule to use [illegible] of antiseptic to wash the wound as it used to be [illegible] ll now make a seriatim study of the import and [illegible] component of the dressing

two minutes, watch in hand, the patient is asked to count, and the time taken and the amount given for loss of consciousness are recorded (generally between 2·5–4 c c), a similar dose is then given more rapidly If a long operation is expected, it is as well to give, as required, the total amount (10 c c) slowly and progressively The anæsthesia lasts four or five minutes, and if this duration is too short, a few drops of ethyl chloride or ether will prolong the anæsthesia to whatever time is required The patient comes round naturally and vomiting is exceptional

INCISIONS

Here again, one must go against acquired habits *A whitlow, wherever situated, must never be opened by a median incision,* for the latter has all the faults it gives poor drainage because it drains the summit of the abscess, it allows herniation of the flexor tendons through the incised edges of the synovial and fibrous sheaths, finally, it leaves a vicious scar, which retracts the finger and makes its use impossible, even if the flexor tendons do not slough out

The principle is the same for the whole surgery of the fingers, and we shall see its application in cut tendons In cases of suppuration, the incisions will be placed on the lateral aspect and they will expose all the tracks of spread of the infection A detailed study of the incisions for each particular case will be made later

DRAINAGE

The mode of drainage is of secondary interest, if the incision has been made in the proper place and is of sufficient length Depending on the case, small drains, narrow rubber strips or gauze wicks may be employed

Drains must vary in diameter from No *15* to No *30*[1] according to the incision *They must never be used in the fingers,* but only in the hand and wrist In the finger there is little room, they press on and cause necrosis of the blood vessels, the skin and the tendons In the hand there is more room, and there are no drawbacks in placing them into the incisions to be described later

In the finger it is better to use rubber strips which are

[1] French Catheter Scale

the wound The *only one that ought to be used in the wound itself* is Dakin's fluid for it is weak slightly caustic and is endowed with considerable power of destruction of dead tissues *it is therefore an antiseptic for elimination* It must not be used once the wound is clean as it then makes the wound bleed and is of no further use

Choice of Type of Dressing

The type of dressing will depend on the actual state of the infected wound Every infection goes through various stages

A stage of inflammatory invasion with œdema lymphangitis and general signs

A stage of elimination pus is draining the swelling is disappearing the necrosed tissues are being eliminated as greenish white hard sloughs and secretion is abundant

A stage of repair—everything that ought to have been eliminated has disappeared the wound is red and *granulating* the cutaneous edges are adherent to their beds and cicatrisation is about to start

Each period requires a different type of dressing

(a) **Inflammatory Period** The infection is general as well as local One must therefore treat both put the patient to bed give him plenty to drink and make use of *vaccines* and drugs as required

This is the stage of the disease when hot and moist dressings are indicated (using either alcohol or Dakin's *fluid both very* dilute) The swabs and the absorbent cotton wool are well moistened and a *layer of non-absorbent cotton wool* is placed on top in order to maintain moisture while *allowing aeration* I have completely discarded the use of impermeable materials even the perforated ones as advised by Kanavel for they give rise to maceration and swelling of the skin The hand *having* been dressed it must be immobilised on a splint and kept slightly elevated The moist dressing is not renewed many times a day the bandage is undone three or four *times in* twenty four hours the non-absorbent cotton wool is removed and the absorbent layer is then moistened with warm sterile water which must not give a sensation of burning *the* temperature of the water must be tested before application the *nurse or the* doctor by pouring some of it on their

non absorbent wool and the bandage are then replaced

Absorbent cotton wool is the essential part of the dressing, for it only will absorb the secretion The more the wound secretes, the greater should be the thickness of the cotton wool For economical reasons, we use cellulose sheets almost exclusively at the American Hospital, its absorptive capacity is greater than that of cotton wool, and its cost price is one-third less It must be enclosed in a layer of gauze (the American dressing), for otherwise it frays Compared with cotton wool, it has the slight disadvantage of being less supple

Gauze swabs are not used to dry up the secretion, for they have a poor absorptive capacity and are very expensive They are simply used to separate the cotton wool from the wound, for there is nothing so disagreeable as a wound that is stuck all over with cotton wool It is, therefore, useless to accumulate layer upon layer of gauze on the wound as is often seen, a single layer is sufficient

Impermeable cotton wool has the sole function of preventing the filtering through of secretions absorbed by the absorbent layer It is not, therefore, necessary to use a large amount of it, a thin layer is sufficient, but it must be a continuous and enveloping layer

The Bandage. The bandage must fix the dressing, prevent its displacement from over the wound and immobilise the hand or the finger when a splint is incorporated It must be well applied and must be sufficiently tight without interfering with the circulation of the part This is why the elastic type of bandage (Velpeau's or crape bandage) is the only one that ought to be used, despite its relatively high cost It is, in my experience, impossible to apply a dressing correctly with gauze bandages, even when moistened, as is often done in the hospitals of Paris

Antiseptics. *Alcohol* is the antiseptic most commonly used, it is expensive, and, as it coagulates the blood, it has poor cleansing qualities

Ether has a disagreeable odour to the patients, it is inflammable and is equally expensive, but it cleans the blood and dissolves the fat For some years now, I have used only two antiseptics that have the merit of being effective and cheap *Dakin's solution* cleans when there is no fat to dissolve, and is an excellent antiseptic, *petrol* cleans every time there are fats to dissolve

The strong antiseptics are useful to clean the skin around

the wound The only one that ought to be used in the wound itself is Dakin's fluid for it is weak slightly caustic and is endowed with considerable power of destruction of dead tissues it is therefore an antiseptic for elimination It must not be used once the wound is clean, as it then makes the wound bleed and is of no further use

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The non-absorbent wool and the bandage are then replaced

Every twenty-four hours the surgeon himself must remove the whole dressing and verify the progress of the wound

(b) **The Elimination Period.** The general signs have improved, suppuration is established and the folds of the skin reappear as the oedema disappears The warm and moist dressings are now discontinued The wound and the surrounding skin are washed with Dakin's fluid, a swab moistened with the same fluid (this prevents the dressing from slipping off on the slightest movement) is then applied to the wound, dry absorbent and non-absorbent cotton wool are then placed over the gauze and a bandage is applied to secure the lot in position This dressing ought to be renewed only once every two days, unless, of course, it is soaked through

(c) **The Period of Repair** The wound is clean and granulating, it still suppurates and will continue to do so until it is completely covered by epidermis The essential thing is not to disturb the process of repair, and the application of antiseptics to the wound must now cease The wound must, however, be protected by a dressing that does not stick (balsam of Peru or collargol ointment, I do not like vaseline because it causes maceration) which must not be renewed more often than twice a week, unless, of course, a rise of temperature, lymphangitis or pain demands an inspection of the wound

The silver nitrate stick now becomes an essential weapon, but it is rarely used properly How many times have I seen wounds, dragging on for weeks, cured in a few days by the proper application of silver nitrate The purpose of this caustic is to burn exuberant granulations which, on account of their height, interfere with the ingrowth of the fine bluish-grey layer of epidermis that encircles the wound One has only to examine the wound with a magnifying lens to realise this fact When the granulations are destroyed, the obstruction is removed and the progress of epidermal growth then takes place sometimes with surprising rapidity

The silver nitrate stick must be potent, the treated granulations must turn clear grey and the wound must then be dressed with a dry dressing Two days later, an irregular and dark scab covers the wound, a scab which is not adherent and which often comes off with the dressing The wound is then dressed with a fatty dressing As a general rule I apply silver nitrate every four days, unless the granulations are very exuberant

The Renewal of Dressings All that precedes is dictated by the anxiety for respecting the process of cicatrisation and for maintaining good immobilisation It means that the dressings must be changed very rarely This is an essential point which we will continue to insist upon in the study of each particular case

Immobilisation of the Hand

Experience gained during the last few years has taught me that an infected hand must be immobilised *at the outset* without waiting for the stage of repair as I used to do Immobilisation gives remarkable benefit to all infections whatever they are are not the cases of adolescent osteomyelitis put in plaster at the present moment while waiting for operation ?

I will not however, go as far as my friend Raymond Bernard who advocates the immobilisation in plaster of all whitlows and abscesses of the hand. A small metal splint incorporated in the dressing is quite sufficient for these cases a splint of sheet metal for the finger and a wire mesh splint for the hand or several fingers An illustration of the latter splint is given on p 27 Fig 6

The splint must naturally be bent in order *to immobilise the hand or the finger in the position of function* (v p 18) We are here dealing with a fundamental principle which can be stated thus *The treatment of infections of the hand entails two phases a surgical period and an orthopædic period*

Mobilisation

Mobilisation must not be early and one must wait for healing of the wound to occur It is only when healing is complete and not before that it must be started In other words the patient will be told to flex his joints only after the reparative stage is over The splint will be removed to allow the changing of the dressings The occasion will be used to mobilise the different joints of the fingers and wrist actively at first *i e* the patient carrying out the movements himself then passively for ankylosis appears gradually Once cicatrisation is complete all the resources of physiotherapy can be utilised but their results are not to be compared with those obtained with constant active movements and occasional passive movement which on the other hand demand much more energy on the part of the patient and of the surgeon

Every twenty-four hours the surgeon himself must remove the whole dressing and verify the progress of the wound

(*b*) **The Elimination Period.** The general signs have improved, suppuration is established and the folds of the skin reappear as the œdema disappears The warm and moist dressings are now discontinued The wound and the surrounding skin are washed with Dakin's fluid, a swab moistened with the same fluid (this prevents the dressing from slipping off on the slightest movement) is then applied to the wound, dry absorbent and non-absorbent cotton wool are then placed over the gauze and a bandage is applied to secure the lot in position This dressing ought to be renewed only once every two days, unless, of course, it is soaked through

(*c*) **The Period of Repair.** The wound is clean and granulating, it still suppurates and will continue to do so until it is completely covered by epidermis The essential thing is not to disturb the process of repair, and the application of antiseptics to the wound must now cease The wound must, however, be protected by a dressing that does not stick (balsam of Peru or collargol ointment , I do not like vaseline because it causes maceration) which must not be renewed more often than twice a week, unless, of course, a rise of temperature, lymphangitis or pain demands an inspection of the wound

The silver nitrate stick now becomes an essential weapon, but it is rarely used properly How many times have I seen wounds, dragging on for weeks, cured in a few days by the proper application of silver nitrate The purpose of this caustic is to burn exuberant granulations which, on account of their height, interfere with the ingrowth of the fine bluish-grey layer of epidermis that encircles the wound One has only to examine the wound with a magnifying lens to realise this fact When the granulations are destroyed, the obstruction is removed and the progress of epidermal growth then takes place sometimes with surprising rapidity

The silver nitrate stick must be potent, the treated granulations must turn clear grey and the wound must then be dressed with a dry dressing Two days later, an irregular and dark scab covers the wound, a scab which is not adherent and which often comes off with the dressing The wound is then dressed with a fatty dressing As a general rule I apply silver nitrate every four days, unless the granulations are very exuberant

are either poorly localised or that have a tendency to spread The dose varies according to the resistance of the patient When I was a resident in the clinic of Professor Delbet the dose used to be 4 6 or 8 c c given every two days in the same thigh The general reaction which follows the injection is severe but of good prognostic significance and the severe pain it gives rise to causes a pseudo paralysis of the lower limb

Bacteriophage

The struggle against infection has been helped within recent years by the introduction of a new weapon—bacteriophage Raiga (2) Sauvé and Jacquemaire Dumas (3) have published cases of whitlow that were cured without operation by the injection of these ultra microbes In the clinic of Moure (4) we have carried out extensive trials first with the simple commercial bacteriophage and later (on account of failures) with a combination of bacteriophage and anti virus, as advocated by Dr Rosenthal (5) We have had results that were surprisingly good and constant in furuncles and carbuncles but its usefulness in whitlows is slight except in cases of *anthracoid whitlows* which are simply furuncles of the fingers and hand and on which we did not operate in order to compare two series of cases (a) 14 operated cases (b) 16 cases treated by combined therapeutic measures (v p 140) In the other varieties of whitlows we have given up its use partly on account of the inconstant results obtained and partly on account of the pain caused by the injections pain which is as bad as that caused by an incision. We prefer surgical treatment for these cases because it is certain and because as a rule it brings about a cure by a simple incision

On the other hand when adequate drainage has been established bacteriophage applied on the dressing has a definite antiseptic action but its value is very difficult to appreciate properly nevertheless we often use it on simple clinical grounds One must not naturally mix bacteriophage and antiseptics for the latter kill the former

Sulphanilamides

These chemical compounds are not to be compared with the common antiseptics whose bactericidal powers demonstrated *in vitro* are supposed to be equally good *in vivo* It is exactly the contrary that happens with the hydrochlorate of

Hand Baths

In all the foregoing, no mention has been made of hand baths, the use of which is, however, very prevalent. In its classical form it used to be given in a long zinc bath, the modern version is a small glass tank with electrical currents passing through

Hand baths are *only admissible if there is no open wound*, they are then useful in relieving pain and in promoting the localisation of pus *But, as soon as an open wound makes its appearance, they must be absolutely proscribed* They give a certain feeling of well-being to the patients, but the danger of re-infection is so great that this easily exceeds their slight advantages It is, in fact, impossible to give aseptic baths They give rise to swelling and maceration of the skin, closure of the incisions and a deep infiltration of the parts, and organisms that are carried in by the fluid are brought into close contact with all parts of the wound At the termination of a well-treated infected wound the tissues have acquired a certain resistance to the original organisms, but their defensive powers are not equal to a new infection This is illustrated by Case 47 (p 204), in which a tenosynovitis that was almost healed resulted in sloughing of the tendon after numerous baths Furthermore, Garlock and later S. Koch have shown that tendons are very resistant to streptococcal infections, but that secondary staphylococcal infection is always fatal to them.

Vaccines

Of all the vaccines in common use, propidon is the only one that has given us satisfactory results It sometimes works wonders, for example, Delbet, at the *Société de Chirurgie*, reported a case of tenosynovitis of the radial bursa that was cured by vaccines alone We have seen an infection of the ulnar bursa which was rapidly improving following the administration of vaccines the temperature had fallen, the little finger was still half flexed and painful on extension and fluctuation could be elicited between the forearm and the hand, it completely cleared up in a few days One must, nevertheless, not hope for too much from this form of therapy, for almost all our severe cases of whitlows and abscesses of the hand had received propidon, and, although it certainly helped the localisation of the pus, it did not cure them In short, its use is indicated in cases of severe suppuration that

grasped the fact that a chemical compound may not be bactericidal by itself also as soon as the drug does not appear to be acting one immediately starts with another drug or rather with a whole series of others the efficiency of which is still much less clearly demonstrated ' (A. Raiga)

ERRORS OF DIAGNOSIS

The Whitlows that do not Heal. It sometimes happens that despite an adequate incision and the best possible after care the whitlow will not heal it continues to suppurate and becomes a sinus The cause for this chronicity must be looked for and if it is not found one must remember that all infections of the hand are not of the ordinary type and that a specific lesion sometimes occurs and is as a rule unrecognised.

The commonest causes of chronicity are *osteomyelitis* which is easily diagnosed with a probe and radiography, *arthritis*—this too is easily diagnosed and its clinical features and treatment will be found on p 182 a foreign body particularly a splinter of wood is an uncommon cause of persistent suppuration and its removal will effect a cure

If none of these causes is responsible for the chronicity then one must always remember that this state can be maintained by daily dressings and strong antiseptics

CASE 36 In 1930 we had two similar cases in young women in whom a cure was apparently impossible The first case was re-operated on two or three times and we removed a portion of tissue for histological examination this examination revealed ordinary inflammatory signs but the patient eventually disappeared The second case had her thumb encased in plaster after we had excluded all the possible causes of chronicity and the wound was healed when the plaster was removed ten days later

Nevertheless when the chronic state still progresses one must make a systematic search for some infection of which a whitlow may be only symptomatic

Syphilis of the Fingers Here is a case from the Saint Louis Hospital

CASE 37 Br 21 years of age a medical student Czecho Slovak This young man while attending the Saint Louis Hospital as a student consulted us for a paronychia that had been incised elsewhere ten days previously and that was not showing signs of

sulphonamidochrysoidine or with the more recent carboxysulphonamidochrysoidine.

"As the result of the epoch-making work of a German scientist, Gerhard Domagk, Levaditi and Vaisman have made remarkable studies on this drug, which has no bactericidal action *in vitro*, but which has a powerful therapeutic action in living beings, while it has the rare advantage of being devoid of toxicity"

"These authors, instead of accumulating clinical evidence, which very often remains unexplained, have tried to elucidate the mode of action of this azoic derivative Their very careful researches were done on experimental streptococcal infections in mice They found that the total blood of a mouse impregnated with this drug is incapable of protecting another mouse of the same breed against streptococcal infection Further, the animals cured from experimental streptococcal infection by this drug do not become resistant to further infections They have thus been led to admit, in order to explain the curative action of the drug, the intervention of means that the organism possesses to defend itself against the aggressor which is, in the circumstances, the streptococcus But it is not by exciting the defensive mechanism by some action on the phagocytes or on the reticulo-endothelial system (as the blocking of this system by colloidal copper proves) that the azoic compound promotes the sterilisation of the infection On the contrary, it is by an altogether new method, rubiazol (sulphanilamide) acts on the infecting organism itself in a very particular way the hydrochlorate of sulphamidochrysoidine prevents, in the living organism and exclusively in this living organism, the encapsulation of cocci in chains, and by preventing the encapsulation of the streptococci it renders them vulnerable to phagocytosis It follows, therefore, that *the ultimate result of therapeutic measures by azoic compounds will depend on the defensive potential of the organism itself, if this potential is deficient* ab ovo, *the curative efficacy will itself be deficient*

"This interpretation of the mode of action of this drug deserves to be clearly shown, for the intervention of the means at the disposal of the infected individual explains the variations of clinical results obtained Unfortunately, this notion is often forgotten, particularly in cases of failure, for the present medical or surgical way of thinking does not appear to have yet

Ducrey s bacillus from the ulcer but at a later stage, one and a half months or over the bacillus cannot be demonstrated particularly when the ulcer has been regularly dressed with antiseptics The diagnosis is then very difficult especially if a history of previous venereal contact is not available If one suspects the true cause of the ulceration it is easy to verify it by auto vaccination on the arm ' (Queyrat)

Tuberculosis Tuberculous ulceration of the fingers is particularly common in nurses and doctors whose work brings them in contact with tuberculous cases Our regretted teacher Lecène had seen a case in one of his colleagues who had cut himself while performing an autopsy Queyrat reports the following case in a nurse who had been wounded by a chipped sputum mug —

The right thumb is very swollen more than twice its normal size it is in an extended and abducted position The palmar aspect of the terminal phalanx shows an area of ulceration of the same dimensions as a one franc piece The edges of the ulcer which extends proximally to the joint crease of the first phalanx, are reddish purple in colour sharply defined and deeply under mined. The outline of the edge is fairly regular except in two places where it is notched

The base of the ulcer is irregular it shows areas of granulation tissue separated by depressions which are more or less deep and which contain a fairly abundant quantity of yellow pus pus is more abundant still from the undermined edges

When a glass slide is placed over the ulcer small yellow points are seen on the base

In the surrounding area the skin is reddish purple œdematous and infiltrated, but there is neither ulceration nor tenderness A diffuse red patch occupies an area starting from the ulcer and extending over the thenar eminence up to the proximal half of the palm of the hand

There is a small supratrochlear gland on the corresponding side and a bigger one (pigeon s egg) at the apex of the right axilla There is no lymphatic gland enlargement on the left side

On the anterior aspect of the right elbow is situated an indurated cord measuring 5 cm in length and 2 cm in width it extends along the course of the median cubital vein and is the result of intravenous injections At this level the skin is brown in colour and adherent to the underlying tissues the veins of the forearm are dilated and prominent

On the anterior aspect of the wrist is a diffuse and fluctuating swelling without any inflammatory reaction indicating a fairly

healing The lesion looked like an ordinary paronychia badly incised, the incision had been made on one side of the nail and the base of the nail had not been exposed The whole area was red, swollen and painful

On March 12th 1930, under "ring" anaesthesia an operation was performed after the technique of Kanavel (v p 136), the detached portion of the nail was removed and the wound was dressed Fifteen days later the condition of the wound was the same, it had, however, an abnormal appearance, it was grey in colour and contained small whitish fragments that stank, the surrounding edges were red and swollen Another operation was performed, the wound was gently curetted but no cause of chronicity was found Eight days later the wound was still the same, but the patient now had a marked roseolar rash and the Bordet-Wassermann reaction was strongly positive The lesion of the finger healed soon after the first injections of novarsenobenzol

Queyrat published, in 1908, 11 cases of syphilitic chancres that had been mistaken for whitlows, and in which the correct diagnosis was made only once before the onset of the secondary rash

Chancroid. In the same paper, Queyrat reported 8 cases of chancroid and gave the following description "The chancroid of the finger is either rounded, or more often, oval in shape, it can measure ½ cm in length by 1 cm in width, the length being in the transverse axis It starts as a pustule that crusts over and when the crust is removed, one sees ulceration of the epidermis and the dermis The base of the ulcer is yellowish-grey in colour, granular and uneven, the edges are sharply defined and undermined (this is easily demonstrated by sliding the corner of a piece of paper under the edges) The ulcer is painful and bleeds on pressure The surrounding area is purplish in colour and œdematous The movements of the finger are limited, and sometimes the underlying periosteum and bone share in the inflammation, a complication which causes more pain and more difficulty in moving the fingers

"In almost all the cases there is an accompanying subacute inflammation of the supratrochlear glands with redness of the skin and tenderness, sometimes there is an axillary adenitis as well

"These digital chancroids have the characteristic feature of lasting a long time, from one to two and sometimes three months

"At an early stage of the disease, it is easy to demonstrate

Ducrey s bacillus from the ulcer, but at a later stage one and a half months or over the bacillus cannot be demonstrated particularly when the ulcer has been regularly dressed with antiseptics The diagnosis is then very difficult especially if a history of previous venereal contact is not available If one suspects the true cause of the ulceration it is easy to verify it by auto vaccination on the arm (Queyrat)

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On the anterior aspect of the wrist is a diffuse and fluctuating swelling without any inflammatory reaction indicating a fairly

large collection in the synovial sheaths of more than a month's duration

"Finally, there is osteomyelitis and consequent enlargement of the terminal phalanx of the thumb and creaking in the interphalangeal joint, the movements of which are limited, but not painful"

The correct diagnosis was suspected on clinical grounds and was proved by histological examination, which demonstrated Koch's bacilli

Analgesic Whitlows The clinical features are typical enough to prevent confusion with the common types of whitlows In Morvan's disease several fingers are usually affected, the finger presents the typical sensory disturbances no pain to pin-prick and loss of hot and cold sensations If the infection is long standing, the hand is short of a portion or the whole of one or more fingers, the fingers are irregular, thick and puffed up Moreover, a general examination will settle the diagnosis, for example, in syringomyelia there is muscular atrophy of the limbs, etc It is precisely because these whitlows are indolent that they are subject to serious complications, cuts and wounds are not felt and secondary infection of external origin becomes superimposed, further, these infections develop in a terrain where trophic troubles are well marked One often sees the terminal phalanx floating in pus without the slightest pain, the tendon sheaths become involved in the process and the pus spreads up to the palm of the hand, the abscess bursts open and large areas of ulceration develop, the pus also spreads deeply to invade the joints and the bones, which necrose and which are eventually eliminated The suppuration stops after a more or less long interval and the sinuses close, but the end-result is complete mutilation of one or more fingers

It is obvious, therefore, that these features differ from those of an ordinary whitlow, from which they ought to be differentiated, for the prognosis and the treatment are totally different Surgical treatment is, nevertheless, indicated in cases complicated by secondary infection, it is then entirely symptomatic, being limited to the opening of suppurating tracts and the removal of sequestra

Mycosis. *Mycotic infections* may be mistaken for the common types of whitlows, because they are very uncommon and because their typical features appear late At the outset,

when there is still no ulceration the symptoms sometimes simulate an ordinary acute infection the finger is swollen and globular the skin is red and tight and there is even fluctuation but the fact that all these signs are not accompanied by any general symptoms and the fact that exploration is absolutely painless permit a correct diagnosis In the cases where the finger is the seat of one or more ulcers of the callous variety which suppurate endlessly with beaded lymphatics and when several incisions have already been made one must think of a chronic infection and particularly a mycotic one It is then, necessary to make a systematic microscopic search for the *sporotrichosis*

All these investigations lead to certain important deductions as to treatment for as Moure (6) used to say surgical operations are useless and do not arrest the progress of the disease they are harmful because they spread the infection to the neighbouring healthy tissues and sometimes even succeed in generalising it and because as is well known treatment with iodine cures sporotrichosis quickly and completely

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CHAPTER IX

SUPERFICIAL WHITLOWS

We shall describe by this term infections that occur in the different layers of the skin, including those which affect the peri-ungual region because the nail is part of the epidermis Their frequency is great (98 cases out of 217 reported by Latzaroff in his thesis (1))

ERYTHEMATOUS WHITLOW

It is usual to describe a fleeting superficial type, the erythematous whitlow, which is characterised by pain, redness, swelling, tenderness and general signs Actually, it is the *onset of some infection* with marked lymphangitis at the point of inoculation A careful palpation must be carried out to try to locate a deep collection of pus, and, if the latter is absent, hot baths and moist dressings should be prescribed The usual course of the infection is complete disappearance of the symptoms and signs in three or four days , in some cases, however, it goes on to pus formation, which must be drained when and where this has occurred The existence of erythematous whitlows that clear up spontaneously is an added argument against early intervention an operation must be performed before the diffusion of pus, but not before its localisation

PHLYCTENOID WHITLOWS

Phlyctenoid whitlows account for nearly half the superficial infections 40 out of 98 cases seen in 1930 They give rise to a pocket of thin pus (a pustule) which raises the epidermis from the dermis Sometimes the latter is perforated and the superficial collection then communicates with a deeper

subcutaneous collection (Fig 33) The dimensions of this deep collection allow one to distinguish a *phlyctenoid whitlow* in which the superficial pocket is comparatively large from a

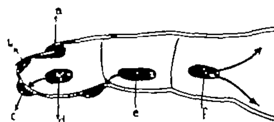


Fig 33 The different varieties of whitlow

(*a*) Peri-ungual (paronychia) (*b*) Sub ungual. (*c*) Phlyctenoid (*d*) Whitlow of the pulp the arrow indicates the formation of a collar-stud abscess. (*e*) Whitlow of the second phalanx, the arrow indicates the site of spontaneous pointing revealed by a pustule (*f*) Whitlow of the first phalanx with two extensions indicated.

collar stud abscess (which is simply a deeply situated whitlow working its way to the surface) Phlyctenoid whitlows occur on the dorsal as well as on the palmar aspects

Clinically it is characterised by a vesicle which is sometimes very voluminous (in one of our cases it extended over the little finger and part of the hand in many others it occupied the whole surface of the pulp) Its wall is so thin that one can almost see the underlying pus (Fig 34) The segment of the affected finger however looks normal there is no redness tenderness or swelling and, similarly the symptoms are very mild after two or three days of pain the latter completely disappears when the formation of pus occurs



Fig 34 Phlyctenoid whitlow

These features differentiate the true phlyctenoid whitlow from the deep whitlow with a collar stud abscess In the latter the superficial pocket is small the corresponding segment of the finger is swollen and tender and the pains do not cease with the formation of pus

Treatment. One must bear in mind the possibility of a deep infection, and this is the reason why we advocate a *two-stage operation* The first operation is performed without anæsthesia for the raised epidermis is insensitive the blister is opened the pus is evacuated and the whole covering epidermis is excised In most cases there is no opening in the dermis when there is one it is useless to do any more for the moment

for if the deep collection is small, it will evacuate itself through the opening If on the other hand, suppuration still continues two days after the first operation and the pain is still present, one must perform a second intervention to drain the deep collection This is done according to a technique which will be described later In our 10 cases, we had to perform a second operation in only 1

The results were uniformly good, and a cure resulted in about eight days

PERI-UNGUAL WHITLOWS

This variety of whitlow is very common (42 cases) It follows punctured wounds around the edge of the nail, or occurs as a spontaneous infection of small cracks, which are so common in this region, many of our cases were consecutive to manicure of the nails

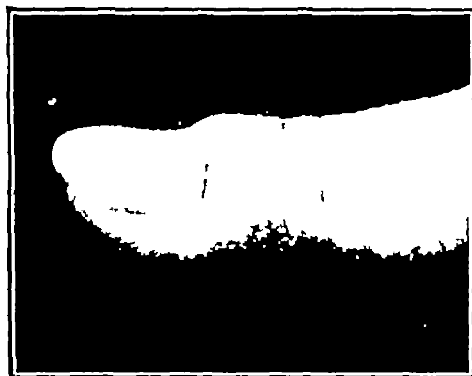


Fig 35 Peri-ungual whitlow

From the anatomical point of view, one must distinguish two varieties, *according to whether or not there is a sub-ungual collection* In our cases, a sub-ungual collection was present in 24 and absent in 16 The superficial variety is a simple peri-ungual septic blister, the deep variety detaches a more or less large portion of the nail (Fig 33) Kanavel has fully described the morbid anatomy of the latter variety and has, accordingly, devised an incision for it The infection may start on one side of the nail, but it always tends to spread towards the base and the opposite side (hence the name "run-arounds" of the older writers) At this stage the base of the nail only is detached from its bed, but with further spread of pus the whole of the nail will eventually be detached (Fig 35) The pus tends to point superficially and usually along the lateral edges of the nail, it may, however, burrow deeply towards the bone, for, as has been shown by Morestin, the proximal basal edge of the nail lies in contact with the bone. Amongst our 42 cases, 8 developed *complications (arthritis*

in 6 osteomyelitis in 1 and spread to the dorsum of the second phalanx in 1)

Clinical Features They are painful at the outset but the pain soon ceases apart from the case where the nail is obviously detached by pus it is impossible to find out by clinical methods alone whether or not there is a sub ungual collection. If the collection is superficial, cure takes place in a few days either spontaneously or after a simple incision if not suppuration spreads or becomes chronic

Complications The involvement of the bone or the joint is marked by a recrudescence of pain and inflammatory signs When the infection becomes chronic the pain ceases and there is a slight but continuous sero-purulent discharge the dorsum of the finger is swollen and there is a purplish hue of that part of the skin which is situated between the terminal joint crease on the dorsum and the nail these features are also present but more marked in the skin of the corresponding lateral surfaces of the finger Pressure applied at this level causes exudation of pus along the edge of the nail and exploration with a probe demonstrates detachment of the nail The detached nail finally falls off and is replaced by a new one which is often deformed and irregular In other cases a large pedunculated mass of granulation tissue a *botryomycoma* appears in the gap between the skin and the nail and grows slowly but unrelentingly until it is completely excised (Fig 36)



Fig 36 Botryomycoma (infective granuloma) appearing at the base of a semi detached nail.

This is a common complication in cases which have been left to progress without operation.

Treatment. The treatment varies according to whether or not there is obvious sub ungual suppuration

(*a*) *There is no sub ungual collection* the case is one of a simple peri ungual septic blister As previously stated the epidermal covering of the blister is excised without anæsthesia If at the end of three or four days suppuration is still active one must perform the complete operation which consists in exposing the nail bed where there is most certainly a collection of pus

(*b*) *If there is sub ungual collection* or else a sinus or a botryomycoma One must perform the complete operation which has been so well devised by Kanavel

for if the deep collection is small, it will evacuate itself through the opening If, on the other hand, suppuration still continues two days after the first operation and the pain is still present, one must perform a second intervention to drain the deep collection This is done according to a technique which will be described later In our 10 cases, we had to perform a second operation in only 1

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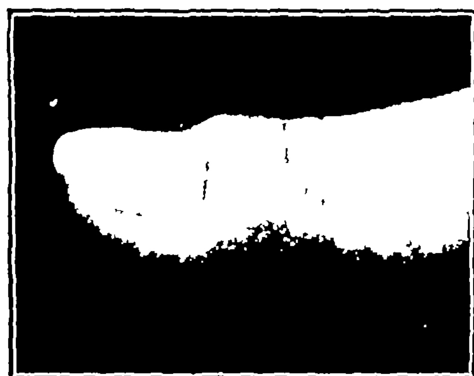


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one case (thumb) followed by a good result resection of the end of the terminal phalanx for osteomyelitis in one case (finger)

These results are excellent we can only find one comparative series of cases in the literature Körbl reported 32 cases following upon manicure of the fingers of which 9 resulted in ankylosis of the finger in the extended position. The ankylosis was due to necrosis of the tendon in some cases and arthritis in others *one of these cases had a finger disarticulated and another the forearm amputated*

SUB UNGUAL WHITLOWS

This type of whitlow is very rare (we had only 2 cases in our series) It is difficult to diagnose for it simulates whitlows of the pulp but its treatment is quite different

Morbid Anatomy Infection follows a prick or a partial detachment of the nail which is of so frequent occurrence The pus collects as a small loculus between the dermis and the nail either at the very tip of the finger or towards its lateral aspect (v Fig 33) When unrecognised the infection is certainly the origin of many cases of early osteomyelitis of the terminal phalanx for the pus burrows under the nail towards the bone and from there it invades the pulp itself The relative theories concerning this direction of spread have been discussed at great length by Carp

Clinical Features The early clinical features are similar to those of an early pulp infection violent pains which progressively prevent sleep a sensation of tightness and throbbing of the finger-end Inspection reveals a diffuse redness but palpation with a blunt pointed instrument reveals a para ungual point of maximum tenderness After three or four days of warm baths and warm moist dressings the pain localises itself an operation should be performed at this stage In some cases one can actually see a small collection of pus just underneath the tip of the nail

Treatment Ring anæsthesia the pocket of pus is opened by a small incision made parallel to the edge of the nail and at the point of maximum tenderness After the pus has been evacuated it is seen that the superior boundary of the pocket is formed by the nail lined with a very thin layer of epidermis A triangular piece of that portion of the nail is

Technique. The finger is rendered bloodless by the application of a small tourniquet around its base, and "ring" anaesthesia is given *The incision* (Fig 37) is so made that a rectangular flap of skin with a proximal base is fashioned It is first made transversely 2 mm proximal to the nail, it is then branched upwards on each side at a right angle with the first incision while keeping parallel to, but outside, the buried edge of the nail The skin flap is then raised by knife dissection, which exposes the lesions The upper part of the nail is detached, but in relatively early cases, the distal part is still adherent, one then removes that part of the nail which is already floating on pus leaving the adherent part in place

This operation presents considerable advantages the affected region is completely exposed, the skin flap is kept open by a gauze wick and will cover the part when suppuration ceases, and the rapidity with which this occurs is surprising (four to five days as a rule) The end of the finger remains protected by the adherent part of the nail, and that is a most important point, when the nail is completely removed, the patients suffer much pain when the finger is lightly touched or dressed during the subsequent days If the distal part of the nail is retained, the finger-end is protected and the dressings are quite painless, the matrix being intact, a new nail will gradually grow and displace what is left of the old one

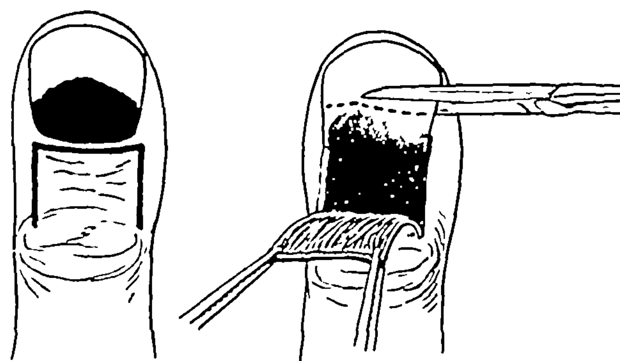


Fig 37 The incision for a peri-ungual whitlow section of the detached portion of the nail

In the very early cases, the pus has not yet extended around the whole edge of the nail In such cases, it is only by raising the rectangular flap that one can establish the degree of spread and the amount of nail to be removed, a procedure which gives as good a result as possible

Results. The simple cases take from eleven to seventeen days for complete healing

The complicated cases had the following additional operations performed disarticulation of the terminal phalanx in 5 cases (fingers), resection of the joint and plaster immobilisation in

one case (thumb) followed by a good result resection of the end of the terminal phalanx for osteomyelitis in one case (finger)

These results are excellent we can only find one comparative series of cases in the literature Körbl reported 32 cases following upon manicure of the fingers of which 9 resulted in ankylosis of the finger in the extended position. The ankylosis was due to necrosis of the tendon in some cases and arthritis in others *one of these cases had a finger disarticulated and another the forearm amputated*

SUB-UNGUAL WHITLOWS

This type of whitlow is very rare (we had only 2 cases in our series) It is difficult to diagnose for it simulates whitlows of the pulp but its treatment is quite different

Morbid Anatomy Infection follows a prick or a partial detachment of the nail which is of so frequent occurrence The pus collects as a small loculus between the dermis and the nail either at the very tip of the finger or towards its lateral aspect (v Fig 33) When unrecognised the infection is certainly the origin of many cases of early osteomyelitis of the terminal phalanx for the pus burrows under the nail towards the bone and from there it invades the pulp itself The relative theories concerning this direction of spread have been discussed at great length by Carp

Clinical Features The early clinical features are similar to those of an early pulp infection violent pains which progressively prevent sleep a sensation of tightness and throbbing of the finger-end Inspection reveals a diffuse redness but palpation with a blunt pointed instrument reveals a para ungual point of maximum tenderness After three or four days of warm baths and warm moist dressings the pain localises itself an operation should be performed at this stage In some cases one can actually see a small collection of pus just underneath the tip of the nail

Treatment Ring anæsthesia the pocket of pus is opened by a small incision made parallel to the edge of the nail and at the point of maximum tenderness After the pus has been evacuated it is seen that the superior boundary of the pocket is formed by the nail lined with a very thin layer of epidermis A triangular piece of that portion of the nail is

then excised, in order to expose completely the focus of suppuration Healing occurs very rapidly, in eight to ten

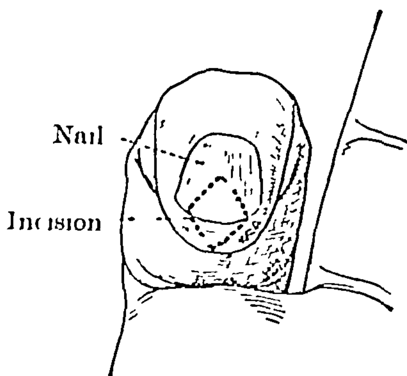


Fig 38 Sub-ungual whitlow, schematic drawing of the incision

Thanks to the excision of a triangular portion of the detached nail and of the adjacent portion of the skin, the pocket of pus is entirely exposed. This variety of whitlow is the one that heals most rapidly (four to five days) when it is properly treated

days, and the nail grows without any deformity When the pocket of pus is on the lateral aspect, one must remove the whole length of the edge of the nail as well as the adjoining cutaneous margin in order to obtain complete drainage

ANTHRACOID WHITLOWS

We understand, by this term, a furuncle or better still a small carbuncle, which always affects the dorsal surface of the fingers, for that surface alone is provided with pilo-sebaceous follicles They occur more frequently on the dorsum of the first phalanx Klapp states that all infections of the dorsal surfaces of the fingers are of the anthracoid type



Fig 39 Anthracoid whitlow

The Anatomical Lesions

Are those of an ordinary carbuncle with " core " formation, that is, a necrosed portion or portions of tissue (Fig 39), healing can only occur when the core or cores have been eliminated The usual course of the disease is very similar to that of other carbuncles, that is to say, they heal well unless an untimely operation is performed We have collected

29 cases and there were only 2 complications following surgical interference an abscess of the dorsum of the hand developed and necessitated dressings for nearly three months before healing

Treatment

The classical treatment is operative local anæsthesia with ethyl chloride spray (we believe that this is the only occasion when this type of anæsthesia should be used and then it must be sprayed twice At the first application freezing is carried out until the lesion turns white a pause of a minute is required

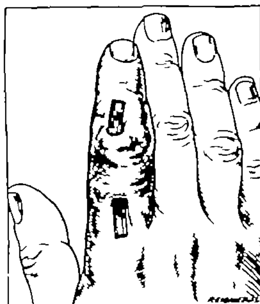


Fig 40 The method of draining a subcutaneous dorsal abscess

Suppuration originated in a furuncle of the middle segment of the finger It then spread subcutaneously as far as the hand. It is useless to incise the whole extent of the area, as this would result in an inextensible scar Make a small transverse incision at the proximal edge of the abscess and pass a rubber strip between this and the centre of the furuncle

before it is applied again) A cruciate incision is now made all necrosed tissues are removed and the resulting wound is dressed We have performed this operation on 16 cases one case developed an abscess of the back of the hand after operation another developed a spreading infection despite excision and we had to have recourse to bacteriophage treatment In the other 14 cases healing took from eight to twenty-one days the variable time being due to the different

dimensions of the wounds, one scar was retractile and gave rise to a little disability

Treatment by Bacteriophage Antivirus. Surprised by the good results *regularly* obtained in furuncles and carbuncles by the treatment associated with the name of Rosenthal (bacteriophage antivirus), we treated 13 cases by this method, without having recourse to surgical interference. They have been reported in the thesis of my friend and pupil, Bernard Dumas

The technique is very simple and consists in injecting daily a few cubic centimetres of bacteriophage antivirus mixture in the infected area Four injections are usually sufficient

The results were excellent, all the cases were cured without the slightest incident and in a comparatively short time (four to twelve days) On the score of these results, we consider the treatment settled and have abandoned surgical operations, not only for these lesions, but also for all other furuncles and carbuncles

Complications

These infections give rise to a good deal of necrosis, there may be loss of the skin over a wide area leading to a corresponding long period of repair

Then again I have seen three cases with subcutaneous suppuration tracking to the hand, such cases must be incised transversely at the proximal end of the suppurating area and drained by a strip of rubber passed underneath the skin from the incision to the original focus of suppuration (*v* Fig 40)

ACUTE SPREADING INFECTIONS

A short debate on acute spreading infections of the limbs took place in 1936 at the *Société de Chirurgie* (Mocquot, Metivet (2)) This subject is of great importance, for it concerns a characteristic anatomico-clinical syndrome which is fortunately rare but considerably grave

We have observed two such cases with fatal issues in the clinic of Robert Monod, and I have seen another with my friend Professor R Dubau in his clinic at the Percy Military Hospital, this case also ended fatally in forty-eight hours

It is difficult to find a term which accurately describes the lesion It cannot be called a lymphangitis because the skin

is also involved with the subcutaneous cellular tissues The Germans call it Erysipelas (3) but in France this term is restricted to an infection which is entirely cutaneous "the streptococcal dermatitis while here we are dealing with a disease in which other structures besides the skin are affected Is it perhaps what the old writers used to call diffuse abscess ? But the bright red colour the involvement of the skin and the development of necrotic areas do not tally with the clinical description of the latter lesion which I, personally have never seen. It would rather appear to be the *gangrenous lymphangitis* of the old authors For these reasons I think

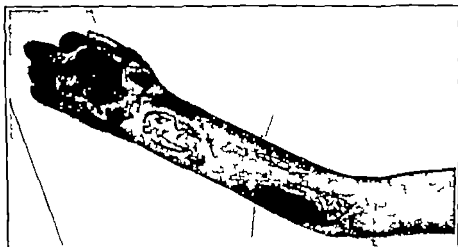


Fig 41 Acute spreading infection. (Case 38, Dr Robert Monod)
The appearance of the lesion on the seventh day the gangrenous patches are well defined and the pus accumulated under them has been evacuated. The portal of entry was in the web between the second and third finger

it is better to call it like the American authors acute spreading infection a term which does not prejudge either the exact location or the infecting organism and which indicates fairly accurately the essential characteristic of the lesion that is its rapid course with features of septicæmia

The lesion is interesting and deserves a special description on account of its *clinical aspect* and the difficulties of treatment

The course of the disease fortunately varies it may be a fleeting lymphangitis it may be accompanied with the formation of distant abscesses the typical case however develops areas of necrosis leading to loss of the skin, which in our case was confined to the dorsum of the hand (Case 38 Fig 41)

Furthermore, the lesion occurs most frequently in doctors and nurses Among the cases reported by Sumner Koch (4), eight occurred in doctors and nurses My friend H P Nelson, the young and already brilliant thoracic surgeon of London, died from this disease last year (1936) at the age of thirty-three Bernardbeig, of Toulouse, suffered the same fate two years ago (1935), two Paris surgeons were more fortunate last year (1936) and escaped with the loss of a finger

It is seen, therefore, that the study of this lesion is interesting from many points of view, if only by setting the problem of preventive initial treatment of septic pricks and small infected wounds

CASE 38 P H, 32 years of age, a bricklayer The patient had scratched the base of his left middle finger On the same night rigors, general malaise, slight pain in the wound The next day, May 25th, 1935, he was admitted to the Broussais Hospital in a serious condition

Examination on admission The hand, forearm and distal part of the upper arm were swollen and bright red, the skin was stretched and a little tender, and inflamed lymphatic vessels ran up to the axilla

Yellow necrotic patches were present on the base of the finger, on the dorsum of the hand and on wrist and forearm The temperature was 104° F, the pulse rapid, the patent's facies and his general condition were those of a severe infection and were very disquieting, urine was scanty and contained no sugar but 750 mgm of albumin

Purely medical treatment was decided upon Propidon, 2 c c, a large and warm moist dressing was applied, and abundant drinks were prescribed

May 26th No change in the patient's condition, temperature was a little lower and the swelling had not extended

May 27th Temperature fell a little, but the patient having had severe rigors, a *blood culture* was taken and was returned negative after forty-eight hours incubation

The lesions The yellow patches had progressively darkened and were now black, the surrounding swelling was soft and gave the impression of early suppuration Propidon, 4 c c, was injected

Without anæsthesia, the black patches on the hand and forearm, now detached by suppuration, were removed with scissors The discharging yellow pus contained streptococci

Warm and moist dressings

May 29th The temperature had suddenly risen to 104 3° F during the morning, the necrosed areas, now bare, suppurated freely and the softened surrounding areas contained pus

Propidon 6 c c was prescribed.

May 30th Temperature fell to 103 6 F suppuration was still increasing

May 31st *Under local anæsthesia* the pockets of pus were explored incisions and counter incisions were made and drainage was provided by small drains There was an abundant flow of pus

The subsequent period appeared favourable for the temperature fell on June 6th the quantity of urine increased and remained on the increase Yet the patient had been very ill he had literally melted away in a few days

His condition remained stationary during the whole month of June the temperature fell but did not reach normal level and the patient was still weak.

At the beginning of July the general condition deteriorated again the urine became scanty and on July 7th the temperature rose to 103 2 F and became intermittent the patient suffering from violent rigors

July 10th A secondary hæmorrhage suddenly occurred from the anti brachial focus of suppuration. Under evipan anæsthesia that focus was explored counter incised further up the arm and drained with a large gauze wick

The hæmorrhage ceased the temperature fell the patient was given large quantities of hæmostatic serum On July 18th the gauze wicks were removed and on the 21st a blood transfusion (500 c c) was given The foci of suppuration cleared up but cicatrisation was slow the temperature remained in the region of 100 F The patient s condition remained more or less the same with an occasional rise of temperature during the whole month of August

End of September cachexia was more severe and an X ray of the lungs showed diffuse broncho-pneumonia from which the patient died on October 3rd 1935

A post-mortem examination could not be performed

CASE 39 B aged 68 a baker On March 2nd prick with a wire on the dorsal surface of the second inter phalangeal joint of the right index finger

On going to bed that night he was taken with a severe rigor sweating and fever

Thursday March 4th 1937 he came to the clinic He was in great pain but it was diffuse and extended over the whole hand Swelling and redness up to the wrist

He was admitted into the Broussais Hospital Propidon and warm baths were prescribed

Friday March 5th the right hand was swollen with much dorsal œdema The swelling extended up to the middle of the arm it was cyanotic diffuse and very painful. All the fingers were flexed but could be extended

Examination revealed further A painful point on the internal border of the thenar eminence , another at the level of the proximal cul-de-sac of the radial bursa, but there was no thickening The wound of entry had disappeared

No enlargement of the axillary glands

The general condition was disquieting, the temperature was 102 2° F , B P 170/90, and above all, there was glycosuria, 53 gm. per 1,000 c c and albuminuria , blood urea, 0 75 mgm per cent

Insulin treatment was instituted

1 hour	sugar +,	acetone +,	20 units insulin
3 hours	,, +,	,,	0, saline 500 c c
5 hours	,, +,	,,	0, 6 units insulin
7 hours	,, +,	,,	0, 5 ,, ,,
9 hours	,, +,	,,	0, 5 ,, ,,
11 hours	,, +,	,,	0, 5 ,, ,,

The pain at the proximal cul-de-sac of the radial bursa suggested the possibility of a tenosynovitis *Under evipan anæsthesia* a lateral incision was made and the proximal cul-de-sac of the radial bursa was explored, but there was no pus The wound was left open (Dr Arviset) and warm and moist dressings were applied

Saturday, March 6th There was no change in the local condition , the diabetic condition was

1 hour	sugar +,	acetone	0, 5 units insulin
3 hours	,, +,	,,	0, 5 ,, ,,
9 hours	,, +,	,,	0, albumin +
17 hours	,, +,	,,	0

Monday, March 8th The swelling and œdema, still cyanotic, had extended up to the axilla A little sero-purulent fluid with some gas bubbles escaped from the incision made on Friday last Further, large bullæ containing a suspicious yellowish serous fluid had appeared on the forearm and the back of the hand Temperature was 104° F

Acetonuria without glycosuria The patient was becoming more and more drowsy After consultation it was decided to explore the swollen areas Under evipan anæsthesia, large incisions were made in the dorsal surfaces of the hand and forearm , greyish sero-purulent fluid oozed out A further series of incisions were made in the forearm with the same result , an incision on the posterior aspect of the upper arm terminated the operation Large moist dressings

The serous fluid collected from the bullæ and from the incisions was sent for *bacteriological and cytological examination*

March 9th The patient was comatose, his breathing stertorous but regular Temperature, 104° F

The swelling was more extensive The incised wounds had a greyish colour and discharged a brown serous fluid

A patch of erysipelas appeared on the arm. The nose the right cheek and eyelid were similarly affected the lesion was dull red in colour very tender and was complicated by a serous blister on the eyelid

The patient died at 1.30 p.m after 7 days of illness

Clinical Features

The Initial Lesion. The initial lesion is always small a scratch or a prick which is in the majority of cases situated on

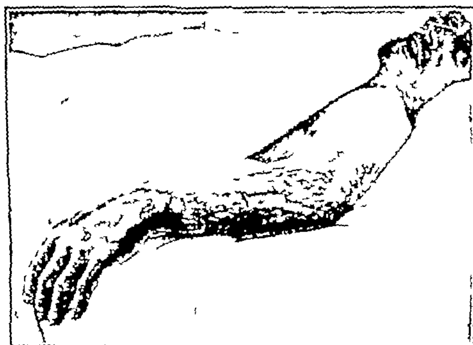


Fig 42. *Acute spreading infection (patient of Professor R Dubau)*

Note the dull granular appearance of the whole infected area where small gangrenous patches appear The small wound of entry was immediately proximal to the head of the fourth metacarpal and was excised on the very afternoon of the day of injury

the dorsal surface In one of our cases the patient had been scratched by a stone on the base of the middle finger In the case of Dubau the patient had been scratched by a frost spike of his horse s shoe The incubation period is very short the patient usually showing signs of an infection of the gravest type after very few hours In other cases the infection appears to follow a mild course and then quite suddenly and on

account of some secondary infection, trauma, or surgical interference, the condition worsens in a few hours and the general signs become very marked the temperature is high (104°–105° F), there is restlessness, and even the facies of the patient alters rapidly, all of which denote the extreme severity of the infection The local signs are characteristic the hand, the forearm and sometimes even the arm are rosy red in colour with purplish lines in some places, the redness is accompanied by an infiltration of the tissues, which is very prominent on the dorsal aspect of the hand and forearm, and which also involves the internal and posterior aspects of the arm. In certain cases one sees, almost at the very outset, certain livid patches, which can be seen to alter at hourly intervals into green, brown and later black On palpation, one is struck by the degree of infiltration of the tissues *the skin is very altered, it has a granular and irregular surface which is easily detected by the finger* Palpation over the whole infiltrated area is nearly painless

The movements of the joints are a little limited on account of the swelling There is no lymphadenitis in the majority of cases, this feature was also absent in the three cases seen by me Nevertheless, most of the cases reported by S Koch showed it, if not at the outset, later on during the course of the disease, and it eventually suppurated

The Course of the Disease. In two of our cases, death occurred rapidly in seven and five days, following the most extraordinary impairment of the general condition the wasted body, the skin dry and stuck to the bones, the eyes hollowed out, the lips dry and open, showing the teeth and the gums (all these features were present within forty-eight hours) and giving rise to the most impressive facies anyone can be called upon to see Besides these cases with a rapid course, there are others in which the march of the symptoms is less overwhelming In the first case, which we observed with Robert Monod, we saw the development, on the third day, of gangrenous plaques, which were immediately excised to allow the escape of purulent fluid containing small pieces of necrotic material A progressive suppuration established itself only the day after, and caused sloughing of nearly the whole of the cellular tissues of the hand and forearm For one whole month we believed that the patient would recover, but it soon became evident that he was not improving and he continued to lose

flesh even without a rise of temperature His wounds were healing up slowly but normally We then detected a diffuse pulmonary infection with a pleural reaction the patient did not recover from this and died in a very cachectic state after an illness that had lasted three months

Lastly in some cases the lesions are fortunately not so extensive *the gangrenous process is localised* and destroys only part of the skin. In the case that Soupault and Raymond Bernard have kindly communicated to me there was on the second day gangrene of the skin of the wounded finger Excision of the gangrenous area with scissors revealed that there was no hope of satisfactory healing The fingers were therefore disarticulated and the patient made a simple recovery

Dr R M surgeon cut himself with the scalpel while operating for a traumatic osteomyelitis of a finger in a workman on July 22nd 1936 The cut was a simple puncture on the palmar aspect of the first phalanx of the left index finger He immediately took the usual precautions There was no reaction on the day of injury

The following day rigor of pneumonia pain and œdema of the base of the finger the œdema spread within a few hours to the whole lateral half of the hand and particularly to the dorsum The œdematous area looked pale and was very tender

The next day there was a blister on the palmar aspect of the finger the œdema had spread to the thenar eminence and there was acute pain. Feeling of tightness There was no great difficulty in moving the fingers There was no lymphangitis and no adenitis

Operation on the morning of July 24th, 1936 (Dr Soupault) Ethyl chloride general anæsthesia The wound on the palmar *aspect of the proximal phalanx was* explored down to the tendon. Incisions were made at the base of the middle finger in the dorsal interspace between the index and middle fingers at the base of the thenar eminence and in the web between the thumb and the index *finger The whole of the fatty and cellular tissue was grey and* some blood-stained serum oozed out but no pus was found Small gauze wicks soaked in hydrogen peroxide were put into the wound and some of the blood-stained fluid was sent for bacteriological examination

The *bacteriological report* was received on the same day *hæmolytic streptococcus*

The night of the 24th the patient s condition was worse the pain increased in intensity and was felt over the whole hand the œdema had spread to the thenar eminence and to the dorsum of the first interosseous space The finger was completely grey and other

blisters had appeared, the forearm was also swollen and the general condition was moderate acute thirst, restlessness, temperature rising continuously to 104° F

The same night consultation with Professor Lardenois it was decided to disarticulate the index finger The night of July 24th, 1936, *operation* (Dr Soupault) under ether general anæsthesia Large palmar and dorsal flaps were raised, and, guided by the appearance of the subcutaneous tissues on the dorsal aspect, he saw an area of cellulitis and followed it up along the shaft of the third metacarpal bone There was nothing to note in the hollow of the hand or in the web between the thumb and the index finger, but the intervening region up to the thenar eminence was affected and the superficial palmar arch had to be tied The superficial flexor tendon was cut at the upper level of the cellulitic area, and the lumbrical, which looked very grey in colour, was removed The cut end of the tendon was fixed to the wound in order to prevent contamination of the common flexor sheath, the wound was left open and hydrogen peroxide dressings were applied

Immuno-transfusion (250 c c) given by Dr Paul Renault

Daily dressings for five days Progressive elimination of all necrotic tissues

A necrotic mass remained adherent to the postero-medial aspect of the wound , this area was also painful The general condition of the patient improved progressively and simultaneously General recovery Healing in two months

Present condition Excellent function of the hand

Clinical Types S Koch describes the following clinical types

The erythematous type, in which the initial lesion abates quickly under medical treatment, but an adenitis with abscess formation may eventually develop

Localised types , these are analogous to the case of Soupault and Raymond Bernard, in which, following a very rapid onset, the infection stops short, causes destruction of the affected part and then dies down

Prognosis One might be tempted to think that such infections are liable to occur in people with a poor physique and poor general health , the cases of Koch and ours entirely disprove this assumption The patient of Dubau was a horse-guard, aged twenty-five, a splendid athlete and in good general health The patient of Monod was a young robust bricklayer's labourer, who had never had an illness of any sort The majority of Koch's patients were similarly young and robust.

It seems to be a question of the extraordinary virulence of the micro-organisms and yet it is not possible to establish a prognosis on the type of the infecting micro-organism only

Koch had bacteriological examinations made in 19 cases

10 cases showed the hæmolytic streptococcus,

3 cases showed the hæmolytic streptococcus with other organisms

4 cases showed non hæmolytic streptococci

1 case showed streptococcus viridans

1 case showed hæmolytic staphylococcus

Treatment

It is difficult to know exactly how to treat these lesions in view of the few studies devoted to them and the number of cases which is fortunately small.

The methods at our disposal are medical and surgical.

Medical treatment is the same as in all serious infections and consists in applying large warm and moist dressings in maintaining the strength of the patient by all available means and in using the most powerful antiseptics we possess At the present time it seems that we have a useful drug in rubiazol (sulphanilamide) and its derivatives although it did not prevent a fatal issue in the patient of Dubau

Surgical treatment consists in treating the wound of entry that is to say in opening or excising it and in exposing any tracts leading from it On the analogy of gangrenous whitlows it is admitted that exposure to air and to antiseptics might help in combating the infection directly

Choice of Method of Treatment. It is difficult to settle the question but from what we know of the progress of infections one is made to realise more and more that an incision is only useful in evacuating a *collection* of pus that is to say after the patient has already struggled and won the battle against the organisms the surgical act in evacuating the pus then comes only to sanction the victory of the patient Now in the cases we are concerned with there is no pus a cloudy serous fluid teeming with micro-organisms escapes through any incisions that may have been performed at the very most one sometimes sees a very small amount of greyish pus oozing out Definite suppuration only occurs after the appearance of cutaneous gangrene but the localisation of gangrene in patches is already an indication that the victim will triumph early

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having risen to 105 8° F and all the features of a severe septicaemia. Forty-eight hours later a diffuse infection had set in and he had died two days later (Sumner Koch)

Medical Treatment. The patient must be put to bed immediately his hand must be covered with a warm moist and sterile dressing and immobilised on a splint which includes the arm and the forearm He should be given immediately ten to twelve tablets of rubiazol (sulphanilamide) or three tablets of septazine every twenty four hours warm and abundant drinks should be given and a special watch should be kept on the heart and lungs When the infection appears to be under control the gangrenous areas are excised and the abscesses opened Rubiazol (sulphanilamide) must be continued for at least fifteen days the dosage being progressively decreased after the eighth day

Preventive Treatment. When the gravity of the disease is realised, it is not at all unusual that attention should be paid to the subject of preventive treatment for the initial lesion is small and as a general rule quite trivial

It consists in sterilising as far as possible the site of entry It is obvious that as soon as one receives a prick even though it is not septic one must first of all make it bleed and then apply an antiseptic either tincture of iodine or preferably mercurochrome This line of treatment seems beyond dispute for we do not believe that any surgeon would advocate the systematic cauterisation or excision of every prick immediately after its occurrence If on the other hand, the prick or the wound shows signs of inflammation (pain and redness) after a few hours the question of treatment then becomes very difficult indeed for it is quite impossible to forecast what course the disease will take (particularly in those cases where a surgeon has been pricked or cut with septic instruments) Must one adopt medical treatment as already described or must one take a more energetic decision and enlarge the wound cauterise or even excise it ? (P Moure)

The results of these various procedures are difficult to assess on clinical grounds alone because one does not know what course the wound would have taken if it had been left alone My personal belief however is that they are of no value and the histological studies of Hudack and MacMaster (5) give us proof of this These authors studied the rapidity of diffusion of coloured particles in living lymphatics with the

surgical interference is, therefore, quite useless if not dangerous

Personally, I am not in possession of sufficient evidence to prove that it is dangerous, but I am convinced of it In collaboration with Dubau, we performed small incisions in the diseased parts, only greyish fluid exuded and the patient died that very afternoon We performed the same operation on another case seen with Monod, mainly because we did not wish to appear inactive in the face of a desperate disease, the patient died the next morning, erysipelas having set in around the incisions and over the nose and the eyelids between the time of operation and death. We cannot, therefore, say that we have been of the slightest help to these patients, but exactly the reverse

Koch, who has devoted a remarkable paper to the study of twenty-two of these cases, is strictly of the following opinion the lesions must have no surgical interference, they must be treated on medical lines only as long as there is no localisation, on the other hand, when the gangrenous process is limited, when the sloughs appear and when abscesses develop, one must, without delay, excise the gangrenous patches and open and drain the abscesses Koch has been impressed by the history of a young medical student, whose sad fate directed his attention to this type of lesion :

"A young medical student had scratched himself slightly on the dorsum of the right index finger The finger became slightly swollen and painful and he persuaded one of the surgeons of the hospital to open it under local anæsthesia there was no pus On the following day the finger was more swollen and more painful, red lines of lymphangitis were appearing on the forearm and the patient looked very ill I advised him to go to bed, to drink as much as possible, to place a large warm and moist dressing over the whole upper limb and, above all, not to have it incised on any account He vigorously protested against this advice, for he was sure that there was pus in the finger Having assured me that he would follow this treatment at home, I was indulgent enough not to admit him into hospital I heard nothing more of the patient and should have completely forgotten him, when, one week later, I saw a notice on the notice board of the hospital stating that first year students were to have no lectures in the afternoon in order that they might attend the funeral of this young man I then learnt that he had gone to see a doctor in the city and had persuaded him to incise the finger, he had then developed severe rigors, the temperature

recovered were all treated on medical lines from the time we saw them they were put to bed large moist warm and sterile dressings were applied to the whole superior extremity and plenty of fluid was given to drink. Incisions were only performed when localisation of the infection became definite or when abscesses were present Five of the cases that recovered developed further infective complications

GANGRENOUS WHITLOW

It happens from time to time that a finger infection which is apparently following a normal course suddenly becomes gangrenous over a more or less extensive area

This complication has been attributed to the ring' anæsthesia to the tourniquet to the use of adrenaline with the local anæsthetic to carbolic acid and to damage of the vessels

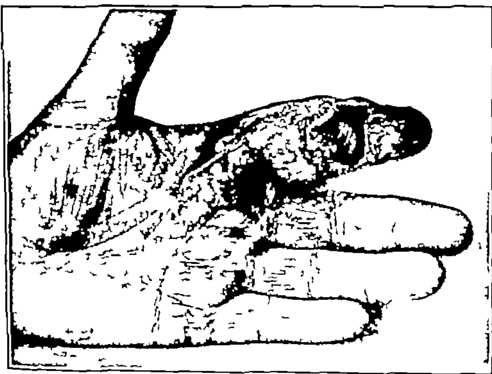


Fig 43 Gangrenous whitlow

The infection resulted from a wound by a lobster claw The wound had been excised and dressed by a practitioner The course of the disease had been apparently normal until the fifth day when the above picture was first seen on changing the dressing There is nothing else to do but disarticulation Note that local anæsthesia cannot be blamed for the complication, since the incision had been performed without any anæsthetic

aid of the binocular microscope, to which they successfully fitted, first, an ordinary camera and later a cine-camera They found that, 30 secs after the intradermic inoculation of the colouring material, the lymphatics were invaded over an area of 14–15 mm , 45 secs after, the invaded area had a radius of 2 55 cm , 1 min 15 secs after, the coloured particles had left the lymphatics and permeated the tissues, and 5 mins after, the colouring matter was as far as 15 cm distant In 2 cases the colouring substance had reached the axillary region 8 mins after an intradermal injection of $\frac{1}{10}$ c c of blue V

The same authors have repeated those experiments with a coloured substance to which bacterial toxins had been added in the proportion of 1 part colouring matter to 20 parts of toxin, the invasion occurred with the same rapidity

It is obvious, therefore, that it is useless to excise a wound of entry when the invading bacteria are already beyond the reach of the knife

Results. Koch gives a fair idea of the gravity of these infections In all he saw or examined 32 cases in which, following a small wound, a lymphangitis had appeared and developed rapidly with marked impairment of the general condition It was, at the outset, impossible to guess the course of the disease In 2 cases the infection turned short and there was neither localisation nor abscess formation In 5 cases the local infection cleared up very quickly, but the axillary lymph glands suppurated, and in some of these the abscess spread to the infra-clavicular retropectoral region

In *15 cases* the infection looked alarming at the outset, but stopped and gave rise to abscesses In the *7 cases* in which the prick was on the palmar aspect the tendon sheaths became infected, in *4 out of 8 cases* in which the lesion was dorsal, localisation occurred on the back of the hand, and in the *other 4 cases* suppuration extended to the hand, forearm and the arm

The *10 other patients* died in from four to thirteen days after the initial injury, one of whom died in thirty-five days from bilateral broncho-pneumonia Let us recall here that the 3 cases we have reported died one in five days, the second in seven days and the third in three months from pulmonary complications

Koch draws the following conclusion . "The 22 cases that

made a report on it at the Congress of Industrial Accidents (Brussels 1935)

Clinical Features The disease manifests itself in two to fifteen days after the injury which may be a small wound or a scratch The clinical features are a sensation of tightness itching and heat localised to the part The small wound has a surrounding zone which is red and dark in colour and slightly raised After a time the redness and swelling extend towards the base of the finger and from there they sometimes spread across to the other fingers

The pain is often severe it is made worse by heat and relieved by cold There is neither rise of temperature nor general symptoms Lymphangitis is rare and adenitis inconstant

The Course of the Disease It usually lasts for two or three weeks but local recurrences are common sometimes many months after apparent cure

In exceptional cases the lymph glands are involved and the disease may become generalised to cause death Buzello emphasises the frequency of articular stiffness as a sequel

Pathogenesis The microbic agent is the *bacillus of swine fever* (*Bacillus erysipelatis suis*) It appears to be a widely distributed organism living as a saprophyte

Treatment. The treatment is entirely medical and it would be a complete mistake to interfere with the lesion surgically The few cases I have seen were treated with warm moist dressings at first and with iodine in alcohol later The dermatologists recommend any reducing agent 4 per cent salicylic ointment or dressings of peroxide of mercury 1 per cent It is always difficult to know whether the lesion has healed spontaneously or as a result of treatment

Buzello advocates X ray treatment (15–20 per cent of an erythematous dose) He prefers this to sero therapy (Rotlauf serum of I G) or to auto hæmotherapy

REFERENCES

1 R LATZAROFF Contribution à l'étude des panaris. (*Thèse de Paris* 1931 Imprimerie Lec)
2. G MÉTIVET Un cas de lymphangite avec gangrène de la main (*Acad Chir*, t LXII pp 1130–1133, 1936)

by lateral incisions None of these so-called ætiological factors stands analysis I have seen 3 cases occur after operations performed under general anæsthesia and without carbolic acid dressings I have seen 1 case after lateral incisions, but I have also seen another following upon a median incision for a digital tenosynovitis

It is, in reality, due to an arterial thrombosis, which comes on without apparent cause and without warning The general health of the patient does not appear to be of any special significance, for in 5 cases diabetes was only present in 1, the others being young and healthy patients It does not seem that one can lay the blame on any special type of organisms either The same applies to the clinical appearance of the whitlow, gangrene may complicate an apparently simple lesion, just as well as an acute diffuse suppuration, which we studied in the previous chapter

Clinical Features. As a general rule, the occurrence of gangrene of part or the whole of the skin of a finger is first noticed when the dressing is renewed The skin is cyanotic, cold and insensitive, later it will turn brownish in colour, as all gangrene does The onset of this complication, which is fatal to the finger, is marked by the absence of pain and of a rise in temperature

Treatment. The treatment is, unfortunately, very simple there is no hope for conservative treatment, and one must disarticulate through healthy tissues as soon as possible

ERYSIPELOID

Erysipeloid is a lesion which is well known to dermatologists, but much less so to surgeons It was brought to my notice by a few patients who were all in the catering trade (fishmongers, tripe dealers, greengrocers and cooks) They presented a curious red and painful swelling that was mostly at the base of the finger, without obvious pus, progressing slowly and sometimes spreading from one finger to another

Historical Note This disease has been studied by dermatologists M Baker (1873) called it "*erythema serpens*" and Rosenbach (1887) "*erysipeloid*" Roederer and Lanzenberg give it the name "the erysipeloid of Baker-Rosenbach" (6) I am aware of only two surgical papers on the subject · Klapp and Beck devote a chapter to it in their book, and Buzello

made a report on it at the Congress of Industrial Accidents (Brussels 1935)

Clinical Features The disease manifests itself in two to fifteen days after the injury which may be a small wound or a scratch The clinical features are a sensation of tightness *itching and heat localised to the part* The small wound has a surrounding zone which is red and dark in colour and slightly raised After a time the redness and swelling extend towards the base of the finger and from there they sometimes spread across to the other fingers

The pain is often severe It is made worse by heat and relieved by cold There is neither rise of temperature nor general symptoms Lymphangitis is rare and adenitis inconstant

The Course of the Disease It usually lasts for two or three weeks but local recurrences are common sometimes many months after apparent cure

In exceptional cases the lymph glands are involved and the disease may become generalised to cause death Buzello emphasises the frequency of articular stiffness as a sequel

Pathogenesis The microbic agent is the *bacillus of swine fever* (*Bacillus erysipelatis suis*) It appears to be a widely distributed organism living as a saprophyte

Treatment The treatment is entirely medical and it would be a complete mistake to interfere with the lesion surgically The few cases I have seen were treated with warm moist dressings at first and with iodine in alcohol later The dermatologists recommend any reducing agent 4 per cent salicylic ointment or dressings of peroxide of mercury 1 per cent It is always difficult to know whether the lesion has healed spontaneously or as a result of treatment

Buzello advocates X ray treatment (15–20 per cent of an erythematous dose) He prefers this to sero therapy (Rotlauf serum of I G) or to auto hæmotherapy

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3 ARTHUR BUZELLO "Die akuten eitrigen Infectionen in der Chirurgie und ihre Behandlung," 1 vol, Urban et Schwartzenberg, Berlin-Vienna, 1926, "Infektiose Komplikationen der Wunden der Hand und Finger" (Report to the 7th International Congress of Industrial Accidents, Brussels, 1935, p 517)
4 SUMNER L KOCH "Acute rapidly spreading infections following trivial injuries of the hand" (*Surg Gyn Obst*, Vol LIX, pp 277–308, 1934)
5 HUDACK and MACMASTER "The lymphatic participation in human cutaneous phenomena" (*Journ Exp Med*, Vol XVI, pp 751–774, 1933)
6 ROEDERER and LANZENBERG "Érysipéloïde de Baker-Rosenbach" (*Nouvelle Pratique Dermatologique*, pp 230–234 (2 figs), Masson et Cie, édit)

CHAPTER X

INFECTIONS OF THE SUBCUTANEOUS CELLULAR TISSUE

Anatomy

THESE common and serious infections develop in the cellular tissue of the palmar aspect of the fingers The three creases on the palmar aspect of the fingers demarcate three segments each of which corresponds to a phalanx These segments are separated from one another by transverse fibrous partitions that run from the deep aspect of the skin to the deep osteo aponeurotic plane These three transverse creases mark out the following spaces (Fig 44)

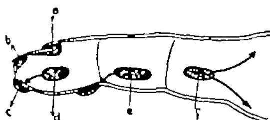


Fig. 44 The different varieties of whitlow

(a) Peri-ungual (paronychia) (b) Sub ungual. (c) Phlyctenoid or Subepithelial. (d) Whitlow of the pulp the arrow indicates the formation of a "collar-stud" abscess. (e) Whitlow of the second phalanx the arrow indicates the site of spontaneous pointing shown by a pustule (f) Whitlow of the first phalanx with two extensions indicated.

A distal or pulpar space, which is the commonest site of whitlow The cellular tissue in this space presents special features as it is not loose but intersected by vertical fibrous strands that tack down the deep aspect of the dermis to the periosteum and that *penetrate the bone*

A middle space in front of the second phalanx separated above and below by the fibrous partitions already described while on the sides adherence between the skin and periosteum separates it from the dorsal cellular tissue Behind the bone is clothed by the deep flexor tendon in its sheath which in turn is covered by the strong fibrous arch *the second pulley* along the whole length of the phalangeal diaphysis

A proximal space in front of the first phalanx is well

3 Arthur Buzello "Die akuten eitrigen Infectionen in der Chirurgie und ihre Behandlung" 1 vol Urban et Schwartzenberg, Berlin-Vienna, 1926 "Infektiöse Komplikationen der Wunden der Hand und Finger" (Report to the 7th International Congress of Industrial Accidents Brussels 1935, p 517)
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5 Hudack and MacMaster "The lymphatic participation in human cutaneous phenomena" (*Journ Exp Med* Vol XVI, pp 751–774, 1933)
6 Ro[illegible] and La[illegible] "Erysipeloïde de Baker Rosenbach" (*Nouvelle Pratique Dermatologique*, pp 230 231 (2 figs), Masson et Cie, edit)

in the latter situation is according to Klapp symptomatic of osteitis

Towards the dorsum the pus gains the lateral aspects of the nail bed so that the association of paronychia with infection of the pulp is not infrequent

Spread in depth The spread of pus to and the invasion of the bone is a complication of such practical importance that a special chapter is devoted to it Once the bone has become involved the joint is speedily invaded Osteitis had already occurred in 14 and arthritis in 8 of the 70 whitlow cases that came under treatment during 1930

Special Propagation of Whitlows of the Pulp of the Thumb Whitlow of the pulp of the thumb is also complicated by osteitis and arthritis but it has in addition two other methods of spread peculiar to itself towards the thenar space (1 case) and along the long flexor tendon (4 cases) The infection of the thenar space calls for no special comment (v p 227) Infection of the flexor tendon sheath was however peculiar in the 4 cases observed by reason of the fact that it *became shut off* either by primary or by secondary adhesions so that the infection remained localised and ultimately led to sloughing of the end of the flexor tendon. This complication appears to be peculiar to the thumb as it has never been observed in the other fingers apart from direct infection during operation.

Clinical Features

Dull pains with a sensation of swelling occur in the early days following infection they are continuous with nocturnal exacerbations and are accompanied by general signs

On inspection the pulp is swollen and red slight oedema spreads to the dorsum and surrounds the nail Gradually these signs become more marked and towards the third or fifth day the stabbing throbbing pain in the finger prevents sleep Palpation is then characteristic the pulp is red tense and hot light pressure increases the pain but reveals that the swollen pulp has become indurated and *has completely lost its normal resilience*—a cardinal sign, which reveals that pus is present and that operation is indicated.

Diagnosis

With an infection localised to the finger-end the difficulty lies in distinguishing between a whitlow with dorsal extension

separated off from the middle space, but communicates with the palm along the lateral aspects of the base of the finger because the first palmar digital crease is only adherent to the deeper structures in the mid-line

The existence of this commissural communication explains the frequency with which infections of the cellular space in front of the first phalanx spread upwards to the cellular planes of the commissure [1]

The cellular tissue of the first and second phalangeal spaces is much looser and less resistant than that of the pulp

An infection which is strictly localised to start with, may commence in any of these segments, and if not recognised or wrongly incised, may spread to the adjacent spaces and to the tendon sheath to result finally in a grave diffuse infection which Chassaignac called "pandactylitis" We hope to show that it is possible to treat the infection while it is still localised, and so avoid this danger of dissemination

WHITLOW OF THE PULP

The most frequent form of whitlow In the 70 cases that I collected in 1930, the thumb (34 cases) and the index were the fingers most often affected

Pathological Anatomy

The focus of suppuration lies in that dense tissue which we have already described as traversed by fibrous strands that run into the periosteum and bone On the second or third day after infection, the tissue is œdematous and infiltrated with yellowish serum around a small area of central necrosis which is seldom larger than a cherry stone When incised it looks just like a boil with very little pus and ill-defined limits hence it is necessary *to excise* the necrotic or doubtfully viable tissue rather than to incise it uselessly

Spread of Infection. Infection spreads from the primary focus in all directions

Towards the surface, the pus perforates the dermis and raises the epidermis to form the classical "collar-stud" whitlow Even if it should burst spontaneously, cure does not necessarily follow, since the opening is too small The opening is, as a rule, on the palmar aspect, sometimes at the tip An opening

[1] See Translators' Preface

round the base Make a half horseshoe incision as figured in diagram 46 taking care to incise sufficiently deep to divide the fibrous strands which moor the skin and prevent the edges from gaping A drop or two of pus exudes and one sees the tiny space it occupied Retracting the anterior lip with artery forceps *which must not include the skin in their grasp* one exposes the necrotic zone and then excises it with fine curved scissors If denuded bone (osteitis) is found or the joint implicated the problem becomes more difficult and is dealt with on p 176 The operation is completed by washing the wound with an antiseptic solution or bacteriophage according to the particular preference of the surgeon or simply by draining it with a tiny strand of gauze or rubber The tourniquet is removed and a gauze swab is pressed by the patient himself on the finger which is kept raised for ten to fifteen minutes till the reactionary flush of bleeding ceases this permits the surgeon to apply a clean and permanent dressing

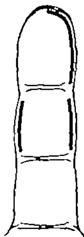


Fig 46 Correct incisions. Half horseshoe in the pulp At the second phalanx, the two lateral incisions allow the introduction of a transfixion rubber strip

The wound usually remains clean and painless for the first two days On the third day, the purulent discharge recommences and persists for five or six days The wound then heals up in from two to four weeks according to the size of the focus and in the absence of complications if the latter should occur, they may if not well treated prolong the lesion *for months*

WHITLOW OF THE SECOND PHALANX

We have found no reference to this type of whitlow in the literature and regard our observations as original in spite of its *relative frequency* Out of 270 cases of whitlow collected in 1930 at the out patient clinic of the St Louis Hospital there were 16 cases of whitlow of the second phalanx 16 cases of whitlow of the proximal phalanx and only 7 cases of tenosynovitis [1]

[1] Our friend and pupil Latzaroff has devoted hi thesis to the study of these 270 cases of whitlow These 16 cases of whitlow of the second phalanx will be found described *in extenso* in his thesis.

around the nail and a primary paronychia In the latter, however, the pain and induration are restricted to the tissues round the nail, and the rest of the pulp, though it may be reddened and swollen, remains painless when pressure is applied to it with a blunt-pointed object

Treatment

The necrotic area should be completely excised The classical "thrust" or "the carefully limited" incision are both quite inadequate Further, *an incision should never be made in the mid-line* because the exposure is poor even with a comparatively long incision, and a median scar is unsightly and painful



Fig 45 Usual bad result of the complete horseshoe incision which was formerly advocated

In the first edition of this book, I recommended the horseshoe incision, which is still called the "valvular" or "shark's mouth incision" Good access is thereby obtained, but the resulting scar is often ugly and painful because the palmar flap retracts to leave a depression that heals slowly The lateral scar is well placed, but towards the tip of the finger a fleshy projection or nodule may be a troublesome result in extreme cases Fig 45 represents one of our worst results The result, on the contrary, may be good if care is taken to carry the incision as near to the nail as possible

To obviate this difficulty, Zur Verth and Klapp advise and illustrate two lateral incisions, leaving a median skin bridge, which prevents this retraction This method is satisfactory,[1] but unnecessary because a *unilateral* "*half-valve*" is sufficient My assistants and myself have used the latter incision in over 50 cases and find that it gives a perfect exposure of the necrotic area, leaves a less obvious scar and heals rapidly (in less than a fortnight sometimes), whereas the complete horseshoe incision takes at least three weeks to heal

Technique. "Ring" anæsthesia distal to a tourniquet

[1] I have seen 2 cases in which the median skin bridge sloughed secondarily

rare We have noted only one case in which osteitis localised to the base of the second phalanx caused persistent suppuration (Fig 56 p 178) Some radiographs in Klapp s book illustrate widespread osteitis of the second phalanx with integrity of the first and third which could only have resulted from an infection confined to the second phalanx

The ætiology is always the same being due to a direct infection of the space by a puncture or cut

Clinical Features The functional and general signs are those of every whitlow but the physical signs differ

On inspection the finger is flexed and rigid, and attempts to straighten it are painful in about one third of the cases The whole digit is red and œdematous and the swelling chiefly affects the second segment (Fig 47) A purulent bleb is often visible in the distal flexion crease Careful *palpation* with a blunt pointed instrument is diagnostic because it elicits tenderness over the whole length of the second segment while, in contrast the pulp and basal segments though œdematous preserve their suppleness and are not tender

An important point in diagnosis *is the complete absence of pain over the tendon sheath in the palm and in front of the first phalanx*

As all our cases were operated on as soon as they came under observation it is difficult to describe the *course of the untreated case* but in 3 cases that were seen at a late stage there was pandactylitis in one osteitis in the second, and arthritis in the third. All three had already been operated on by other surgeons Many cases of suppurative tenosynovitis are probably consecutive to an untreated or badly treated infection in this locality and the fact that we have had so few cases of tenosynovitis is probably because we intervened early and adequately

Diagnosis. Diagnosis depends essentially on palpation which reveals the contrast between the painful affected zone and the healthy neighbouring segments

It is easy to recognise a whitlow of the second phalanx from one of *the pulp* but rather more difficult to distinguish an infection of the *second from one of the base* The appearance however of a whitlow of the basal phalanx is so characteristic with its asymmetrical swelling bulging and redness of the corresponding web that the diagnosis should present no difficulty to anyone who has once seen it The differentiation

Pathological Anatomy. *The site of the pus* is characteristic (v Fig 11) and can be easily demonstrated after the collection has been evacuated Proximally towards the palm and distally towards the tip of the finger the fibrous partitions already described are apparent On each side the collection is limited by the skin attachment to the lateral aspects of the phalanx. Behind, by the deep flexor tendon in its sheath—well protected by the stout aponeurotic pulley, which hides it from view

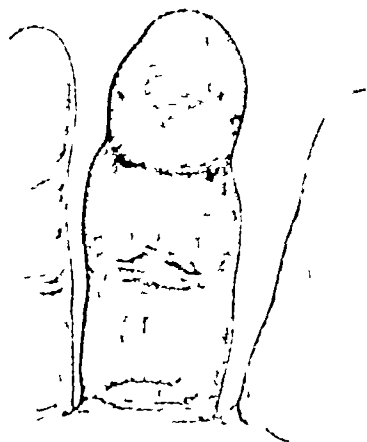


Fig 17 Typical aspect of a whitlow of the second phalanx with swelling restricted to the second segment of the finger and a pustule at the distal finger crease

The pus in the space thus defined is usually more fluid and contains fewer sloughs than that of whitlow of the pulp It is also more abundant and more easily evacuable after incision

The lines of spread are characteristic That *towards the skin* is most frequent, the pus collects under and raises the epidermis in a bleb, which usually lies in the distal flexor crease, where it forms one variety of "collar-stud" abscess In one case only did the pus discharge from the middle segment of the finger, and then it did so through the infected wound We have seen it open on one occasion only in front of the second flexor crease *Spread into the adjacent spaces* is quite exceptional, in one case a slight invasion of the pulp was noted, and that did not need any special modification of treatment, in two cases, all the finger spaces became involved—the *pandactylitis* of Chassaignac—and necessitated amputation. Lastly, in one case the first phalanx became involved

Secondary infection of the tendon sheath is quite exceptional, and we have never seen it, this is probably due to the fact that, in its whole extent in front of the second phalanx, the stout pulley protects the tendon, the only point of weakness being at the level of the distal flexion crease where the pulley ends The distal cul-de-sac lies there immediately subjacent to the skin, and the sheath is in danger of injury if a misguided incision is made at this level just where the pus tends to point

Extension of the infection to the bone is possible, but very

Finally either a dry dressing or hot fomentation is applied in accordance with the choice of the surgeon

Progress after operation is simple Pain, redness and swelling persist for three or five days after evacuation of the pus when gentle pressure over the palmar aspect of the phalanx shows that the discharge of pus and sloughs has ceased the drainage strip is removed the wound heals by the twelfth day

Results In 6 of 16 cases (40 per cent) there was *complete recovery of function* by the time the wound was soundly healed at the end of the third or fourth week In 3 the function was perfect when they were last seen but the wound was not completely healed and 4 only attended for a few days after operation. Amputation was necessary in 2 cases *one* for pandactylitis with spread to the hand the finger being dis articulated with resection of the head of the metacarpal to drain the infected cellular spaces *the other case* had been previously incised elsewhere he had arthritis of the second joint and the finger was disarticulated at that level

We trust that many surgeons and practitioners will learn to recognise this particular variety of whitlow which since we have learnt to recognise it does not seem to be infrequent for we have ourselves treated 16 cases We would emphasise that any other incision except that described is not only ineffectual to drain the pus but tends to infect adjacent healthy areas

WHITLOW OF THE FIRST PHALANX

Infection of the basal segment of the finger is relatively infrequent (16 out of 217 cases) and is caused by direct infection of the space through a puncture or an incised wound The

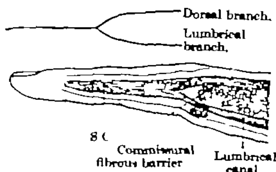


Fig 49 The skin has been removed from the lateral aspect of the finger the section includes the corresponding inter metacarpal space.

S C the subcutaneous tissue of the finger Note—the commissural fibrous barrier the dorsal layer of cellular tissue the palmar lumbrical canal. Above Plan of incision. It is essential to split the commissure to throw the two foci into communication.

from tendon sheath infections offers more difficulty As I pointed out in a communication presented to the *Société de Chirurgie* by P Moure (1), the "hook" sign (*signe du crochet*) is not pathognomonic of phlegmon of the sheath because this sign was present in the absence of sheath infection and *absent in undoubted cases of tenosynovitis* in which the distension of the sheath has been relieved by spontaneous or operative opening *The only sign that seems to me to be absolutely characteristic of sheath infection is pain along the line of the sheath with a maximum point of tenderness at the proximal end, i e, over the palmar cul-de-sac of the sheath* It seems probable that many cases labelled tenosynovitis are in fact whitlows of the second phalanx, which would clear up with bilateral incisions, and this may explain the successes recorded by this method of treatment in what are supposed to be infections localised to this particular segment of the sheath

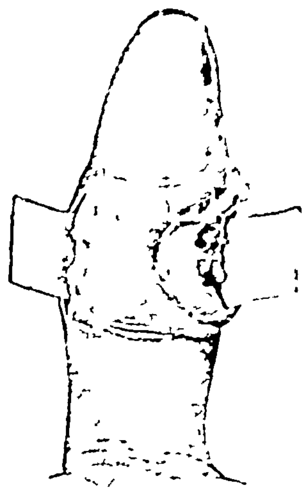


Fig 18 Whitlow of the second phalanx after operation

Treatment Treatment is simple once the diagnosis of the exact site of the infection has been made, but success depends here, as elsewhere in the surgery of the hand, on perfect anæsthesia and a bloodless field, conditions which can be simply secured by a basal "ring" infiltration with 0 5 per cent novocaine and a tourniquet round the base of the finger

When a purulent blister has formed, the incision is carried through it and a grooved probe is introduced to explore the limits of the collection of pus and to verify its localisation A lateral incision (Fig 46) is then made either directly or down to the point of the probe This incision must be kept sufficiently far back on the lateral aspect, so as to be behind, and not endanger, the digital vessels After the pus has escaped, a pair of Kocher's artery forceps is pushed across through the lateral incision, and a second incision made on the opposite side over the projecting points, which are then separated to grasp and pull through a strip of dental rubber (Fig 48) There is no danger of pressure ulceration of the sheath, which is well protected at this level

arthritis tenosynovitis and phlegmon of the commissure but as none of these complications occurred in our 16 cases which cleared up after simple incision we cannot give further particulars

Quite recently I have seen a case of tenosynovitis which complicated a whitlow in this locality and which gave rise to no clinical signs The exploration which was carried out because the infection persisted, revealed a necrotic tendon which called for amputation.

Diagnosis The differential diagnosis from whitlow of the second phalanx is easy Tenosynovitis is distinguished from it by intense pain along the line of the sheath with maximum tenderness over the superior cul de-sac while the commissures remain painless Lastly a *commissural phlegmon* is accompanied by symmetrical swelling and oedema that involve the bases of the adjacent fingers (v Figs 82 and 84)

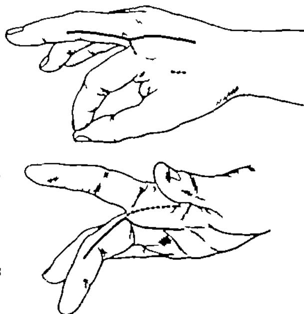


Fig 51 Incision of a subcutaneous whitlow of the proximal phalanx.

Above Digital incision.—br dorsal br lumbrical (dotted)

Below Digital incision.—br lumbrical br dorsal (dotted)

The incision is completed by splitting the web The length of the incisions depends on the extent of spread of the tracts of infection.

Treatment. In earlier editions we recommended a three branched incision one limb of which opened the side of the finger the second the palmar and the third the dorsal extension While it is sufficient to treat a primary infection of the commissure by dorsal and palmar incisions transfixing the web we found that these did not suffice to clear up an infection that had commenced in the finger and that was apt to persist till spontaneous opening took place on the lateral aspect of the base of the finger This is why we still advise as in 1028 the use of the three branched incision (Fig 51)

Technique. General anaesthesia and tourniquet

signs of inflammation develop in two or three days, but suppuration takes place rather slowly, five to seven days It soon involves the lateral aspects of the finger, and then spreads to the small commissural space I formerly accepted Kanavel's teaching that the further spread of infection to the deep central palmar space took place *via* the lumbrical canal (Fig 49), but the dissections of H Évrard have confirmed our clinical observations that the infection remains confined to the commissure and spreads towards the dorsal aspect without any tendency to gain the palm of the hand I was pleased to note that Klapp had made the same observation In short, when pus has resulted from an infection of the basal phalanx, it fills the small space in front of the basal segment and the corresponding web space *on one side only*

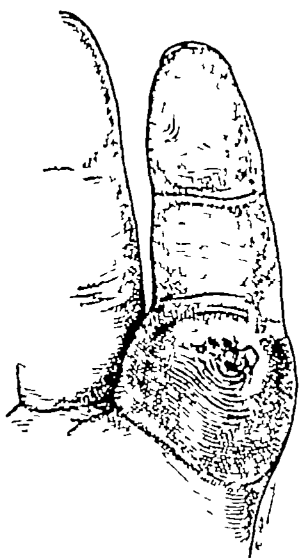


Fig 50 Whitlow of the proximal phalanx with asymmetrical swelling localised to the first segment

I formerly saw no reason to distinguish this secondary infection from a primary infection of the commissure, but now realise that the signs and the incisions required are different, in the former there is collection at the base of the finger, which is not present in the latter and which needs to be treated

Clinical Features. The functional and general signs are those of a serious whitlow with this difference, that pain predominates at the base of the digit An *asymmetrical swelling* is observed at the base with involvement of the commissure The neighbouring finger is separated from the affected finger The palmar aspect of the base of the finger is red and swollen, and redness and swelling spread well back towards the dorsum In many cases lymphangitis develops and spreads towards the wrist

Palpation confirms the diagnosis, as the point of maximum tenderness reveals the site of pus The pain is intense over the palmar aspect of the basal segment and equally intense over the web, *but is completely lacking over the upper cul-de-sac of the tendon sheath in front of the metacarpo-phalangeal joint* Further, though the finger is often flexed, it can be easily extended

Evolution. The non-operated whitlow progresses towards

Incision *The digital branch* opens the lateral aspect of the finger along the line of union of the dorsal and palmar skin and is carried up to the web

The second and third limbs are then made by splitting the web from before backwards from the base of the digital incision The two fingers then separate to give a wide exposure of the infected area

There is no danger of wounding the vessels by these incisions because the pus separates the skin from the vessels, which are pressed back to lie in close contact with the base of the finger

A counter-incision on the opposite side of the finger is unnecessary and undesirable as it may cause sloughing of the undermined bridge of skin This regrettable complication in one of my earlier cases led to prolonged suppuration, and the scar that resulted caused persistent contracture of the finger

Dressing As the wound is large and exposes fully the area of suppuration, no drains are required It is sufficient to pack it loosely with iodoform gauze When the discharge ceases, in three to six days, the packing may be omitted and the fingers allowed to approximate

Results. In all but one case, healing took place in about three weeks In the exception, disarticulation was necessary because the patient was a diabetic and the infection had lasted for two weeks and probably caused pandactylitis The functional and æsthetic results are perfect and the splitting of the web is without drawbacks The scar becomes concealed in the digital commissure and can only be seen with difficulty after the inflammatory swelling of the region has subsided

REFERENCE

1 M Iselin "Note sur le traitement des ténosynovites digitales" (*Bull Mém Soc Chir*, t XLVII, pp 456–465, 1931)

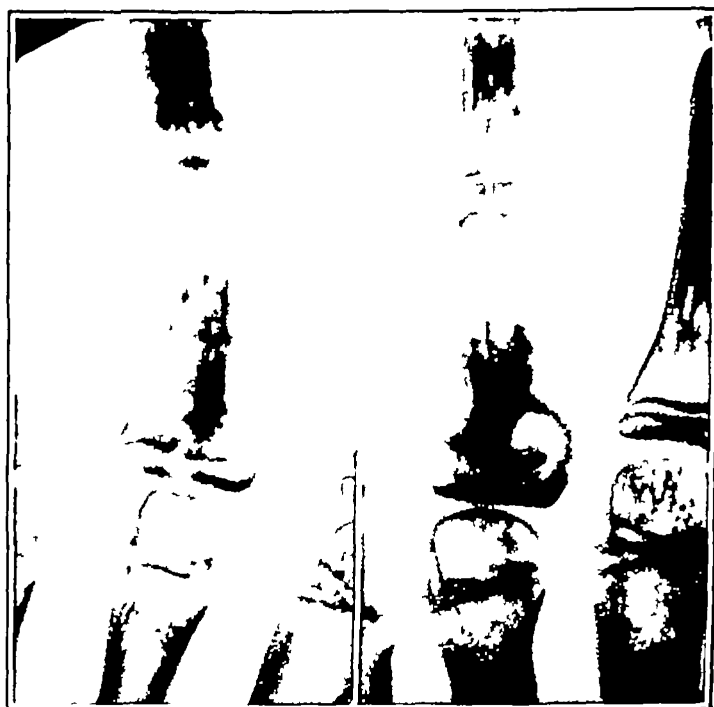


Fig 52 Phalangeal osteomyelitis

The appearance of the hand was that of a commissural phlegmon which was incised in the usual manner The first radiograph was taken at the end of three weeks because of the persistence of the infection The finger was immobilised for two months Several sequestra were discharged and it took four months to heal *Right* X ray after healing had occurred, the articular cartilage is destroyed and the finger is already shortened

CHAPTER XI

OSTEITIS OF THE PHALANGES

(Panaritium Ossale)

We prefer the term osteitis of the phalanges to the bone whitlow of the German writers because infection of the bone is merely a complication of the other infections we have described except in the acute phalangeal osteomyelitis of children where the lesion is *primary* and due to a blood borne infection The *secondary* form is nearly always caused by an infection of the pulp

PRIMARY OSTEITIS

It is only seen in infants who also may suffer from all the other superficial varieties of whitlow and especially from paronychia While infants may of course suffer from all the superficial varieties of whitlow and especially from subungual infections any *deep whitlow* should be regarded with suspicion We agree with the teaching of Lannelongue that in infants infections of the cellular tissues and of the sheath never spread to the bone When the bone is involved the infection has commenced there as an acute *primary osteomyelitis of the phalanx* and must be treated by a free incision down to the periosteum The same remarks also apply to the metacarpals (Ombrédanne)

Klapp observes and demonstrates by radiographs that the epiphyses are not generally involved in the necrosis and that complete regeneration may occur after the sequestrum has been removed

SECONDARY OSTEITIS

This condition is comparatively frequent There were 14 cases of osteitis of the terminal phalanx in the 70 cases of whitlow that we collected in 1930 while in one only was the second phalanx affected (v p 178)

Klapp and Beck in their book entitled Das Panaritium devote no less than forty out of the total number of 136 pages

to the subject These authors have studied the subject with particular attention, and their experience is based on over 100 cases, whose progress was followed in serial radiographs

Anatomy

The frequency of osteitis of the terminal phalanx is due to the structure of the cellular tissue and its relations to the periosteum and blood vessels "In the pulp, solid fibres run from the deep aspect of the skin to the periosteum, which is here composed of two layers an external, loose and vascular, and an internal which is bloodless but composed of thick and resistant elastic fibres, which penetrate the cortex of the bone alongside the vessels in the Haversian canal to constitute the fibres of Sharpey These vessels traverse the cortex and form a close network in the medulla, whereas the fibres of Sharpey do not run beyond the compact layer In consequence, there are in addition to the nutrient arteries of the phalanx a considerable number of little vessels that arise in the periosteum and run into the bone marrow" (Klapp and Beck)

As a general rule, the vascularisation of the base and of the diaphysis of the terminal phalanx is distinct, as each receives a separate artery (Braus) *The artery to the base* arises at the level of the second phalanx, while the *diaphyseal artery* arises from the collateral digital arteries as they traverse the pulp

Ætiology

The infection reaches the bone along the subcutaneous fibrous strands which, as we have seen, run directly to the periosteum and into the interior of the bone through the Haversian canals Direct inoculation of the interior of the bone by a penetrating wound is exceptional It is difficult to determine the cause of the osteitis neither age nor physical condition is important, it is not more frequent in diabetic subjects, the type of organism (streptococcus or staphylococcus) has no special influence The duration of the infection, however, is important Some of our cases, seen late, already presented sinuses, but the majority had been badly incised and often dragged on for several weeks

It is difficult also to determine exactly the *mechanism* of the necrosis Klapp recognised the importance of both the *stripping up of the periosteum* by the pus which, when extensive,

deprives the corresponding osseous zone of blood and *thrombosis of the nutrient vessels* compressed by the infection in the restricted pulp cavity Finally in certain cases extensive thrombosis affects all the vessels of the finger tip and results in necrosis of both the soft parts and the bone as in the gangrenous whitlows described on p 153

Pathological Anatomy

The bone affected by osteitis necroses to a variable extent and one of the most interesting facts that emerges from Klapp s study is the possibility it affords to predict from the site and extent of the sequestrum the conditions of regeneration. The following varieties may be distinguished —

Partial Necrosis which separates off a small rounded and often fragmented sequestrum about the size of a lentil either from the tip or from the lateral aspect of the terminal phalanx The sequestrum however may be *elongated* and comprise the whole length of one of the borders of the bone or in exceptional cases it may be *basal* and eliminate only the epiphysis while the diaphysis remains normal

Total Necrosis is always accompanied by arthritis The terminal phalanx is bathed in pus and the head of the adjacent phalanx may be invaded (v Fig 53)

Subtotal Necrosis to which Klapp has called attention, only

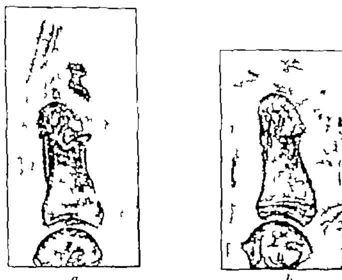


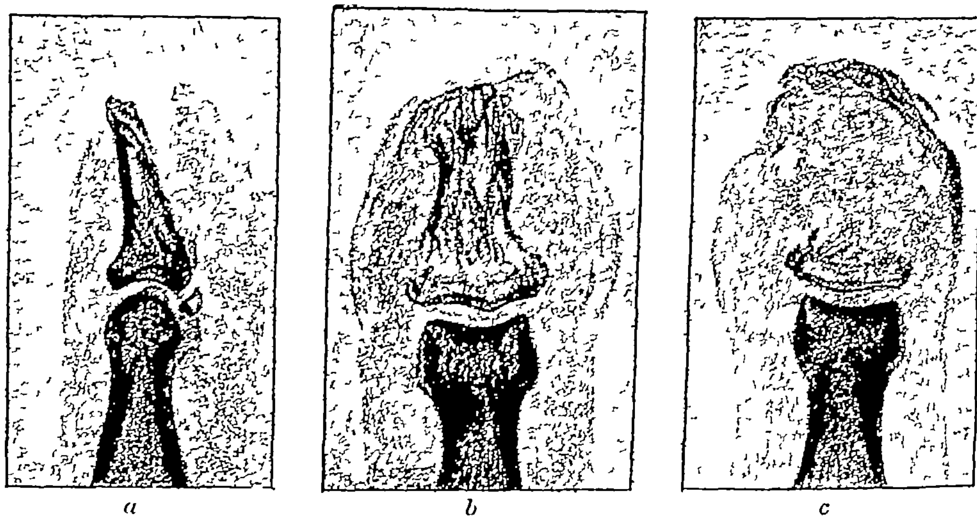
Fig 53 Osteitis of the terminal phalanx of the thumb with arthritis.

(a) Sequestration of the terminal phalanx with erosion of the head of the proximal phalanx (b) Complete reconstruction of the head after elimination of the terminal phalanx

affects the shaft and the tip and respects the base, the line of separation forming at the level of the metaphysis (Fig 54), the survival of the epiphysis being due to the different vascular supply of the two portions of the bone As the artery to the base arises in front of the second phalanx, it escapes the compression and the thrombosis, which affect the pulp and which block the diaphyseal artery

Possibility of Regeneration. Credit is due to Klapp for having shown that regeneration of the necrosed and eliminated phalanges is not the exception (as was always believed), but the rule *when certain anatomical conditions are present*

Conditions of Regeneration The length of the sequestrum is of primary importance The loss of substance after elimina-



a b c

Fig 54

(*a*) Intervention has revealed the existence of an osteitis which is not shown on the radiograph (*b*) Sequestration has taken place at the site of election at the junctions of epiphysis and diaphysis (*c*) The sequestrum has been removed

tion of *small* sequestra is rapidly replaced by simple periosteal proliferation (*v* Fig 53)

When, with complicating arthritis, *elimination is complete*, bony regeneration almost never occurs Lorenz, however, has published a case (quoted by Klapp), and the late A W Meyer showed me some radiographs of reconstructed (though deformed) phalanges that were fused with the adjacent phalanx, they had taken months to form and the functional result hardly justified the trouble Therefore, in practice and especially in industrial accidents, it is useless to expect any

regeneration of a totally necrosed phalanx after suppurative arthritis

When *necrosis is subtotal* the base remains intact and protects the articulation (Figs 54 55) and *regeneration may be expected* when certain conditions are satisfied the infection of the soft parts must be slight it is therefore important to remove

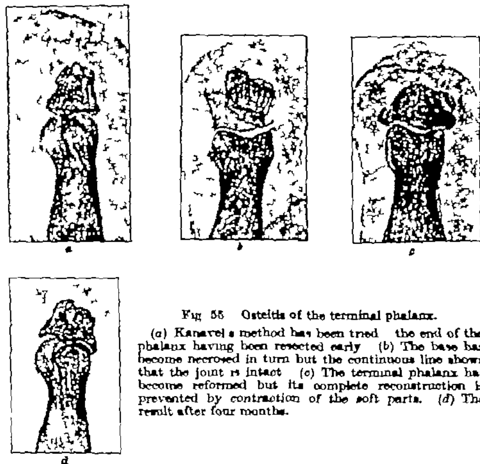


Fig 55 Osteitis of the terminal phalanx.

(*a*) Kanavel's method has been tried the end of the phalanx having been resected early (*b*) The base has become necrosed in turn but the continuous line shows that the joint is intact (*c*) The terminal phalanx has become reformed but its complete reconstruction is prevented by contraction of the soft parts. (*d*) The result after four months.

the whole of the necrotic tissue at operation the soft parts must conserve their shape because the bone cannot find a place *to grow when they have retracted* the *periosteum must remain* intact and in Klapp's view a certain amount of bone and bone marrow must always be conserved as in his view periosteum alone cannot reproduce bone The last premise is generally true as it conforms with the usual rules of bone regeneration after sequestration but even where the phalanx has been wholly eliminated one may still hope for perfect regeneration provided that the joint has not been involved (Fig 53)

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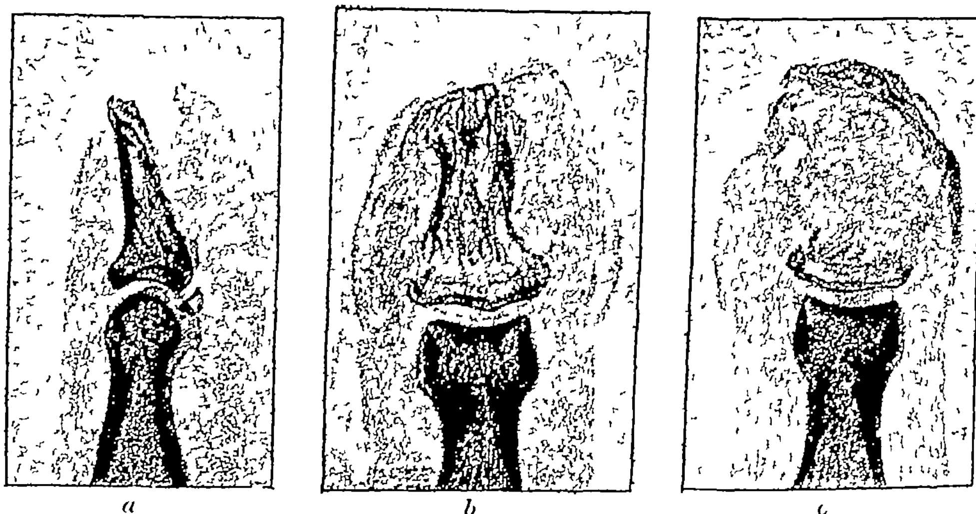


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on the contrary if the sequestrum is subtotal one may see in successive films the shadow take form and gradually develop as the phalanx becomes reconstituted

Prognosis

One can offer no prognosis till the size of the sequestrum is known then if it is partial the terminal phalanx will reform if subtotal it may and probably will reform but even if it should not do so in its whole length its base at least will be preserved with the insertion of the long flexor Lastly should the terminal phalanx be lost from osteitis complicated by arthritis, no reconstruction can be anticipated The finger will be shortened and the long flexor useless In the latter case the head of the second phalanx which has been attacked in some degree by the infection usually becomes reformed with that alteration in shape to which Klapp and Beck drew attention its head loses its normal rounded shape to become thin and pointed taking the shape of a terminal phalanx which it now is This is well shown in a personal case (Fig 53)

Treatment

Conservative and radical lines of treatment have always had their advocates The conservative surgeons follow the example of Hüter and leave the sequestrum *in situ* for several weeks after it has become delimited, in order that it may serve as a scaffold for the new phalanx but the persistent suppuration that results defeats this purpose The opposite line of treatment is that described by König If bone necrosis has taken place over a considerable extent of the phalanx it is useless to conserve it especially in dealing with the terminal phalanx and one must amputate or disarticulate Kocher and de Quervain hold the same opinion, and so does the classical French teaching (Quénu Tixier and Patel (1))

As the anatomical studies we have just detailed show that regeneration is the rule and consequently a process that must be assisted modern methods of treatment tend to be conservative and fall into two groups that of Kanavel and that of Klapp and Beck

Kanavel having recognised that when the base survived regeneration could be expected proposed that *as soon as osteitis was diagnosed even before the sequestrum had become*

The completeness of regeneration, in our experience, varies chiefly with the state of the soft parts. Even with retraction during healing, the base may be reformed and may prove of greatest value, since it preserves the insertion of the flexor tendon

Clinical Study

Klapp and Beck state that it is possible, even before intervention to detect phalangeal osteitis by the clinical signs alone—namely, the *club-like swelling* of the finger and *the pain which is particularly severe around the circumference of the base of the affected phalanx* But in actual practice, the osteitis is only discovered (*a*) during a properly conducted operation with field rendered bloodless, when after excision of the area of necrosis one comes down on denuded bone, (*b*) when post-operative healing fails, the sinus is almost always due to osteitis and the diagnosis can be confirmed by feeling bare bone or a free sequestrum with a probe and/or by radiography

Radiography. The findings are those of any osteitis In the first stage even when exploration has revealed bare bone, nothing abnormal can be seen in the radiograph (*v* Fig 54 (*a*)) Later on in ten or twelve days, a varying extent of decalcification appears either at the tip, side or base At this stage the shadow of the little bone is irregular and interspersed with darker areas Later, sequestration manifests itself by formation of a darker zone (Fig 54 (*b*)) which represents the necrosed portion, which, being cut off from the circulation, conserves its richness in mineral salts, which are opaque to X-rays

Evolution

As soon as the sequestrum has been removed, suppuration ceases and the sinus heals up, if not, other sequestra are probably present If none are found on exploration, we should suspect either arthritis or even tenosynovitis We have seen sinuses kept up by necrosis of a flexor tendon within its infected sheath that had failed to show the signs characteristic of that lesion (hooked finger, pain along the line of and over the upper cul-de-sac of the sheath)

The wound being healed, it takes from three to six weeks for the loss of bony substance to become filled up With partial sequestration, the radiographs show little modification, but

ten days longer before repeating the X ray examination When it has formed forceps should be introduced into the sinus which is usually large enough to permit of removal of the piece of bone No anæsthesia is required *but two or three attempts* may be necessary if several sequestra are present

(*b*) Osteitis indicated by Persistence of a Sinus A radiograph is indicated then with local anæsthesia and a tourniquet a half horseshoe incision is made (unhappily a small median incision has usually already been made) and the necrosed bone and sequestra are removed if they have already become demarcated.

(*c*) Osteitis complicated by Arthritis Don t hesitate Disarticulate the terminal phalanx forthwith, making as large a palmar flap as any previous incisions permit because as suture is impossible it will retract to a surprising extent on account of the suppuration. It may be necessary to remove the head of the second phalanx (which may itself be involved) or even to disarticulate the second phalanx to make sure of a sufficient flap

(*d*) Osteitis complicated by Tenosynovitis Theoretically it should be possible to treat each of these lesions separately on the lines laid down in this book. Practically the result is very unsatisfactory as each lesion by itself is difficult to cure Up to the present it has been our practice in a similar case to disarticulate the finger at its base since all the cases of tenosynovitis were not recognised till the tendon was necrosed and nearly completely destroyed It is then easy to make a sufficiently long palmar flap

Results

We do not know in what percentage of cases the terminal phalanx regenerates and Klapp and Beck and Kanavel give no figures to assist us Our personal experience of cases followed throughout and controlled by radiographs is too small to be of any value The period of healing is always long Klapp puts it at six weeks in our experience two or three months is more likely to elapse before the injured man is able to return to work But it should not be assumed that this is an argument in favour of systematic disarticulation, since we have seldom seen an amputation necessitated by prolonged suppuration even with a satisfactory flap heal in less than six weeks

demarcated, the terminal phalanx should be resected after reflexion of the periosteum towards its base He hoped thus to gain time by removing at once that which might require to be removed later on

Many arguments suggest themselves against this "active" treatment In the first place, it is impossible to forecast the extent of bone necrosis after osteitis has set in, it is illogical, or at least premature, to sacrifice the distal two-thirds of a terminal phalanx where perhaps the ultimate necrosis might be restricted to a tiny flake of the tip or to one border of the bone Secondly, the soft parts lose their support and retract Lastly, in an exceptional case that we were able to follow from start to finish by radiographs, the base we had left sequestrated in turn (*v* Fig 55 (*b*)), and then only did suppuration cease and regeneration commence to reform ultimately the base only, this is also shown in the series of radiographs which Kanavel himself published and which we reproduced in our first work

Klapp and Beck, on the contrary, advise leaving the denuded bone alone in the early stages, because it may not necrose They confine their intervention to a careful removal of all the infected cellular tissue and sloughs, in order to suppress the chief cause of persistence of the suppuration *They treat the case just as if there was no osteitis* At the end of ten days or a fortnight, sequestration is obvious if it is inevitable, and the prognosis, so far as regeneration is concerned, depends on its extent The sequestrum is then removed and the wound heals, but meanwhile any possible bone regeneration is taking place This is an excellent technique that our experience has led us to adopt

Technique. (*a*) WITH COMMENCING OSTEITIS "Ring" anæsthesia and tourniquet The complete "horseshoe" incision recommended by E Quénu should not be employed, one should make a half horseshoe or hockey stick, which keeps the soft parts stretched in length by the intact nail, even if the bone should eventually be removed The necrotic area is excised and a surface dressing applied as if there were no necrosis[1]

Ten days or a fortnight later a radiograph will show whether a sequestrum has formed, if not, one should wait eight or

[1] A W Meyer stated in a recently published article that he had abandoned systematic excision of the necrotic area as recommended by Klapp (*Deut Zchf f Chir*, pp 439–448, 1931)

shortened by 1 5 cm. The patient a provincial surgeon was enabled to resume his profession and to play the piano

A case such as this is in our opinion, one in which judicious treatment of the initial lesion, which was probably either osteitis of the terminal phalanx or an interphalangeal arthritis would probably have prevented extension of the infection to the first phalanx.

REFERENCE

1 TIXIER and P[illegible]. "Précis de pathologie chirurgicale t. VI., p 605 et suiv Masson et Cie, édit.

OSTEITIS OF THE SECOND PHALANX

I have only had one case under my care, the details of which are as follows —

Case 40 Mme Desh , aged 47, for more than two months presented a sinus of the index which had developed after a punctured wound After several days with acute symptoms the spontaneous discharge of the collection led to subsidence of the symptoms The radiographs showed a cavity in the base of the phalanx (Fig 56) Under anæsthesia, simple curettage with removal of the edges of the cavity effected a cure in a fortnight



Fig 56 Localised osteitis of the second phalanx

There are in Klapp's book several illustrations of osteitis, which is of especial importance in the thumb The other digits should be amputated when the osteitis is total, but it is essential to conserve the thumb Our aim must be to maintain the length of that digit during the reconstructive period Continuous traction is, therefore, indispensable to counteract the tonicity of the flexors and extensors An ingenious method for that purpose was described by Huguier to the Surgical Society of Paris in 1921

Case 41 Following an interphalangeal arthritis caused by a septic punctured wound, the whole of the first and the base of the second phalanx of the thumb became necrosed These bones were removed through a dorsal incision twenty-one days after the onset of the arthritis Huguier wished to maintain the length of the affected digit during the period of suppuration so as to enable him to insert an osteo-periosteal graft later on, after the infection had cleared up He, therefore, got Dr Real to construct a little gold splint devised to combat the pull of the tendons and to keep the terminal phalanx separated from the metacarpal The outer ends of two transverse arms attached to the splint were joined by an elastic band, while their inner ends, hooked into the wound, were separated by the pull of the elastic band to maintain the desired lengthening He was surprised, in a man of 40 years, to find that the bone reformed and increased progressively in density, till in twenty-four days the first phalanx became reconstructed though

We describe those details which are of practical importance (v Fig 57)

The joint surfaces are formed by the head of the proximal phalanx (or metacarpal) and the base of the adjoining distal phalanx The head is markedly convex and resembles closely in miniature the lower end of the femur with trochlea and two condyles The base of the phalanx is, on the contrary like the upper surface of the tibia slightly concave from before backwards and with a cartilage covered surface much smaller in extent than that of the head

The capsule is attached round the cartilage close up to the joint on *the base of the phalanx* but on the head of the adjoining bone it is attached to the neck at some distance from the joint more exactly on the dorsal aspect it is attached just beyond the cartilage on the palmar aspect its attachment is proximal to the projection of the tiny condyles

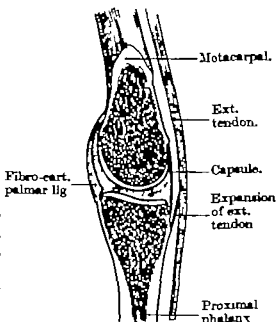


Fig 57 Section of the metacarpo-phalangeal joint. Note the two deep culs-de sac anterior and posterior which cover the head of the meta carpal. (After Rouvière)

The collateral ligaments are the strongest they are attached to the lateral tubercle of the head and spread out fan wise to gain attachment to the lateral aspects of the base Further the anterior part of the capsule situated near the base is very strong and covered by cartilage In the thumb this girdle is particularly strong and includes the two sesamoid bones in its thickness Farabeuf has emphasised the pathological importance of this fact

The synovial membrane clothes the inner aspect of the capsule and forms two culs-de-sac around the articular head one is dorsal and shallow the other palmar and nearly 1 cm deep This synovial cul-de sac presents on a small scale exactly the same drainage difficulties as the knee joint

CHAPTER XII

ARTHRITIS OF THE FINGERS

(Panaritium Articulare)

INVASION of one of the phalangeal articulations by infection is a grave complication, which may occur under three different conditions

By direct inoculation from a punctured wound or a wound on the dorsum opening the capsule We have already discussed the determining causes on p 61 The arthritis is then primary

By spread from a neighbouring infection such as whitlow, osteitis or tenosynovitis In such a case the first articulation is seldom, and the second and third more often, involved Kanavel thinks that the tendon sheath does not adhere to the metacarpo-phalangeal as it does to the second, to which it is intimately united

By Metastases An infection of any kind may be carried by the blood stream and cause an interphalangeal arthritis, but this occurrence is exceptional Kanavel and Klapp have reported cases of gonococcal arthritis in this situation I have operated on a similar case (*v* p 187) Klapp and Beck have observed 2 cases of streptococcal infection, one following a breast abscess, the other after a paronychia of a neighbouring finger

Frequency

These infections are comparatively rare as a primary lesion During the year 1930 we personally treated 7 cases, and Klapp and Beck report a similar number Arthritis complicating a whitlow or *secondary arthritis* is, on the contrary, much more frequent In 1936 and 1938, I operated on 8 cases, which are described in Cordies's thesis (1)

Anatomy

The methods of treatment are determined by the anatomical disposition of the articulations of the fingers

We describe those details which are of practical importance (v Fig 57)

The joint surfaces are formed by the head of the proximal phalanx (or metacarpal) and the base of the adjoining distal phalanx The head is markedly convex and resembles closely in miniature the lower end of the femur with trochlea and two condyles The base of the phalanx is on the contrary like the upper surface of the tibia slightly concave from before backwards and with a cartilage covered surface much smaller in extent than that of the head

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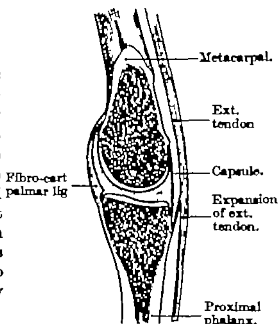


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Pathological Anatomy

The anatomical lesions are those seen in any arthritis

In the early stage there is simple synovial effusion which gradually becomes turbid and thick and which is accompanied by œdema of the synovial lining and capsule, without any involvement of the cartilage

When the disease is fully established, the joint is full of pus, the cartilages exfoliate in places and the capsule becomes distended The pus then spreads beyond the joint, tending to do so rather towards the dorsal than the palmar aspect, which is protected by a thicker portion of the capsule It then spreads easily in the tissues on the dorsum In exceptional cases, however, the capsule may burst anteriorly to open into the flexor sheath, especially at the level of the second articulation, where it is closely adherent (Kanavel)

Anatomical Progress Progressive destruction of the joint takes place, its ligaments are stretched and cartilage destroyed , the ends of the bones are involved and, towards the second or third week, osteitis becomes manifest but *involves especially the base of the distal phalanx*, while the head of the proximal phalanx remains intact for a longer period The ultimate result may be either destruction of the distal phalanx, or ankylosis, or dislocation of the joint

Clinical Features

Each variety shows different clinical features

Primary arthritis is the most typical The initial lesion is frequently small in size and consists of a simple punctured wound Signs of joint involvement are not seen till the second or third day, when spontaneous pain or pains on movement appear, while the infected wound becomes slightly inflamed and begins to discharge The signs then progress rapidly and become characteristic The joint assumes the semi-flexed position of least tension, the dorsal aspect becomes red and œdematous, especially around the wound, while the palmar aspect remains little altered The pain and general signs may be marked in some cases Lastly, in the stage of diffusion, one may observe a dorsal abscess which is superficial and may be fistulous, raising the skin coverings at a distance from the joint Palpation reveals abnormal mobility and crepitations, which indicate respectively stretching of the ligaments and destruction of the articular cartilage

Arthritis from a Neighbouring Focus Arthritis by propagation is frequently difficult to diagnose as its signs are masked by those of the causal whitlow

In our experience the possibility of joint involvement must be suspected when a whitlow that has been carefully opened does not heal It can be diagnosed with certainty when a dorsal sinus and joint relaxation are present

At an earlier stage it is only manifested by chronic thickening of the finger with redness and dorsal œdema that predominate towards the base even if only the terminal joint is affected The finger then assumes a conical aspect In such cases, operative intervention may be necessary to determine the cause of the chronicity

Metastatic arthritis is very rare and manifests itself by the classical signs of arthritis pain, heat redness and dorsal swelling semiflexion of the joint and pain on passive movement

Evolution

If the arthritis is untreated the course is slow and according to the particular circumstances it ends in —

(*a*) Destruction and extrusion of the distal bone involved which is most often the distal phalanx Klapp and Beck however present radiographs showing elimination of the second phalanx

(*b*) Ankylosis of the joint in good or bad position some times in subluxation

(*c*) Abnormal mobility of the joint especially when the distal articular end is subluxated (always towards the dorsum)

All these eventualities are deplorable and should be avoided by appropriate treatment

Prognosis

Prognosis depends on the variety of arthritis and the time of intervention the earlier the treatment the better *Arthritis arising from a neighbouring focus* is the worst because it is associated with extensive lesions in themselves difficult to treat *Primary and metastatic arthritis* are of equal gravity they often abort and do not progress to suppuration When suppuration occurs they are easier to treat because they are isolated.

Diagnosis

Diagnosis depends on the clinical signs dorsal swelling and abnormal joint mobility (Klapp and Beck lay stress on pain elicited in the affected joint by pressure on the tip of the finger)

When a sinus is present, a probe may be passed into the joint

Radiography is of little assistance in the early stage, as it shows no change When, towards the second or third week, decalcification and erosion of the joint interline are manifest in the radiographs, the clinical signs are obvious

Differential diagnosis differs with the ætiology. In a primary arthritis it is all essential to diagnose the joint involvement in spite of the frequently benign appearance of the entrance wound The escape of fluid or pus *on movement* of the joint is the best and often the earliest sign In *arthritis secondary to a neighbouring lesion*, the difficulty lies in detecting the arthritis on suspicion aroused when a well-treated primary infection fails to subside

The use of a probe or surgical exploration under anæsthesia makes it possible to eliminate the other causes of chronicity, osteitis, sloughing tendons, or an inadequately drained extension, while keeping in mind the possibility of symptomatic whitlow, nervous lesion (syringomyelia), tabes, and ulnar nerve lesions, which may all be complicated by osteitis or arthritis in their later stages *Metastatic arthritis* is easily recognised, even when a sinus is present, because there is no antecedent injury The recognition of *acute articular rheumatism* presents little difficulty , and *gout*, even when in the latter the tophus is fistulous, may be recognised by the multiplicity of the lesions, the shadow of the concretions in the radiographs and the particular character of the pains

Treatment

Methods

The non-operative treatment of phalangeal arthritis, as of arthritis in other situations, consists essentially in *immobilisation* and modifying injections (bacteriophage, Lapointe , "Vuzine," Klapp and Beck, etc)

Surgical treatment is either radical by *disarticulation* at the affected joint line, or conservative by draining the joint.

Simple drainage by *arthrotomy* is seldom efficacious on account of the complex structure of the joint with its deep dorsal and palmar culs-de-sac The best drainage is afforded by *resection of the head of the proximal phalanx*—an operation that was proposed by Hüter in 1869 (2) There was no mention of this method in French literature so far as I am aware until the publication of my book in 1928 It was however practised by many surgeons and was taught me by my late teacher Lecène who in turn attributed it to Peyrot a pupil of Dolbeau who contributed several classical works on infections of the hand.

Operative Indications

The indications naturally depend on the particular variety of arthritis and on the digit affected in the thumb the treatment adopted must be much more conservative than in the fingers

Arthritis Secondary to a Neighbouring Lesion Radical treatment is essential when an arthritis is *secondary to an osteitis* disarticulation is indicated

If *the arthritis is associated with tenosynovitis of a finger* there is no point in conservative treatment as the tendon is in process of sloughing in such a case disarticulation of the *whole finger* (p 206) is indicated by reason of the infection of the tendon sheath rather than the arthritis However I have on one occasion, saved a useful middle finger that was thus affected by treating the tenosynovitis first by my method and then the arthritis of the second phalanx by resection of the joint and plaster (v Case 6 in Cordier s thesis)

If on the contrary *the arthritis affects the thumb* and is complicated by tenosynovitis of the long flexor one must be as conservative as possible for example in *osteitis of the terminal phalanx* that bone is excised and the sheath is drained as if it were the only lesion the basal phalanx is thus preserved. In *arthritis without marked osteitis* there is nothing against making at least an attempt at resection of the joint and drainage of the sheath particularly in a young robust patient anxious to escape with a minimum of mutilation In other and more adverse conditions it is preferable to disarticulate the end joint and to drain the sheath of the long flexor tendon

Primary Arthritis The particular method of treatment is determined by the stage of the arthritis

(a) *In the early stage*, no operative treatment is called for. Following the advice of Tixier, Pollosson and de Rougemont, it is essential to immobilise as completely as possible on a moulded palmar splint Injection of the joint with one or other preparation may be added

Lapointe relates the case of a youth, aged twenty, affected by a suppurative arthritis of the metacarpo-phalangeal joint of the left little finger and of the left radio-ulnar joint Without bacteriological examination, he injected bacteriophage on four occasions after puncture aspiration into both joints and cure was obtained in a fortnight

I have studied for more than six months the action of bacteriophage in infections of the hand (*v* p 125) without any similar success, which was so decisive as to encourage further trial of the method Klapp and Beck attach great importance to treatment by Vuzine, an antiseptic that gave remarkably successful results in gunshot wounds of joints Their technique is as follows —

The affected joint is injected through the wound or fistulous tract with a solution of Vuzine of 1/1,000 or of 1/500 combined with 0 5 per cent novocaine As much of the fluid is introduced as possible, as it escapes immediately and thus washes out the joint A dressing soaked in the same antiseptic is then applied Pain increases after the injection with a little febrile reaction The discharge increases to diminish after the fourth day, it then ceases and painless movements become possible The results obtained appear to be excellent Of 7 cases of primary arthritis, all were cured with normal mobility in the recent cases, and with varying degree of restriction of movement in cases that were of more than three weeks duration, and that were already complicated by destructive lesions

The results of this treatment appear to be excellent, but I have no experience of it, in place of Vuzine, which is unknown in France, mercurochrome which is a powerful and non-caustic antiseptic may be employed We have had the opportunity of observing a certain number of joint wounds at Saint-Louis Hospital in 1930 Some became progressively worse and were operated on, but the majority cleared up with simple immobilisation and disinfection of the skin As in all cases of arthritis, the first essential step in treatment consists in immobilisation After that essential has been secured,

further antiseptic or biological treatment may be added if time is not thereby wasted but if suppuration should persist then the only resource is surgery

(b) *When suppuration is already established* medical methods of treatment that have proved futile to arrest the progress of the infection should not be persisted in. When the diagnosis is assured—operate As a general rule always *resect in the thumb* but when dealing with *one finger* the indications are based on social or psychological considerations if the patient is young and intelligent and follows a skilled occupation it is desirable to avoid mutilation *a resection of the joint must be performed* if not it is better to disarticulate Resection in effect calls for four to six weeks of treatment and immobilisation, and ends with a stiff finger which is painful to start with but which can only be restored to usefulness by perseverance and co-operation on the part of the patient himself These indispensable psychological conditions are seldom present in works' accidents and the majority of unskilled labourers are better satisfied with a finger shortened by one or two phalanges or even completely amputated rather than with a shortened finger which is stiff and painful and which they are unable to make use of for an indefinite period Further the period of incapacity is shorter after amputation than after resection—three to four weeks in place of four to six weeks

To sum up a resection should always be done in the thumb but in the finger only in selected cases (and particularly for arthritis of the first and second joints) I should add however that in recent years I myself have given up disarticulation—all my cases have been treated by resection

Metastatic Arthritis *In metastatic arthritis immobilisation* on a rigid metal splint or plaster is essential from the start and will lead to cure in the majority of cases If the lesions progress in spite of complete immobilisation and suppuration persists with fistulæ and bone destruction the case must be treated by *resection* as in a primary arthritis I have only had one personal case of this kind

CASE 42 Ger Louis 22 years designer came to consult me on April 12th 1930 with a gonococcal arthritis of the metacarpo-phalangeal joint of the middle finger of the right hand After eight to ten days of pain and swelling an abscess opened spontaneously on the dorsal aspect He dressed it himself but the discharge increased and movement became progressively more painful He

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the war of 1914–18 in a long series of cases of arthritis of the large joints with excellent results and it is only just that it should be called the Lyons method. M Leriche in Vol I of his Thérapeutique Chirurgicale (3) devotes a chapter to this particular method of treatment which may be read with great advantage I myself have been completely satisfied by its application It has never given rise to the slightest trouble In the earlier cases I was afraid and removed the plaster at

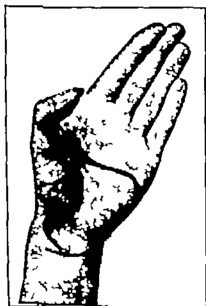


Fig 58 (*a*) Resection of the inter phalangeal joint of the thumb Splint being moulded

The palmar splint made of iron wire is modelled on the surgeon's hand with the thumb held in the position of function.



Fig 58 (*b*) Resection of the inter phalangeal joint of the thumb Splint completed

The wire splint has been covered with a plaster bandage the joint operated on is lightly dressed; the splint is being fixed.

the end of twelve days or a fortnight and by so doing delayed healing by some weeks As I grew bolder I left the plaster alone for a whole month and invariably found that healing was completed by that time except maybe for a granulation that required touching with caustic

The Dressing Vaseline gauze was used for the first dressings with a poor result the skin became macerated pus accumulated under the vaseline and the plaster stank so much that it had to be removed for that reason alone At present I am using balsam of Peru with satisfaction. It has proved a good antiseptic without maceration or disagreeable odour Two

decided to attend Saint-Louis Hospital after the illness had lasted about three weeks The urethral discharge was slight but gonococci were still present, neither staphylococci nor streptococci were found in the joint pus Immediate X-ray examination showed decalcification of the bone ends with obvious destruction of the articular surfaces and epiphyses

On April 14th, under general anæsthesia, the head of the third metacarpal was resected, and after the cavity had been lightly curetted to remove bony débris it was swabbed out with ether and dressed with balsam of Peru It was then put up in plaster on an angled palmar splint

When on May 15th the plaster was removed the wounds were healed The finger was flexed in good position, the joint painless and slightly mobile A fortnight later the movement had increased in range and the young man resumed work

Technique of Resection

Time of Intervention. Operation should be performed early, because one must not forget that its *real purpose is drainage* It is restricted to removal of the head of the metacarpal (that is to say, the intact epiphysis, while the diseased epiphysis, that of the phalanx, is left *in situ*) because this resection does away with the dorsal and palmar culs-de-sac and exposes widely the joint cavity The distal epiphysis recovers speedily once the suppuration is cut short, as I have seen in all my cases

The operation includes two stages of equal importance the first that of the surgical resection, with anæsthesia and a bloodless field, the second, of orthopædic immobilisation in the position of function in plaster

The Surgical Procedure. Two short dorso-lateral incisions or a cutaneous flap with proximal base are made, these allow the displacement of the extensor tendon to either side to explore both sides of the head The latter is then resected with bone-cutting forceps and any pockets that may exist are opened up This concludes the surgical treatment No drain must be inserted and the wound must on no account be sutured

Orthopædic Stage of Treatment The finger must now be encased in plaster, which is left on for a month This closed plaster applied to a virulent infection is contrary to the sentiments and practice of many surgeons Nevertheless, this method of treatment was used by the surgeons of Lyons during

placed then a layer of impermeable cotton wool and finally the plaster bandages These are carried round the wrist enclosed beforehand in stockinette and then include the thenar eminence and thumb The plaster need not be thick three or four layers suffice to form an efficient protective and immobilising casing

Progress after Operation

The pains of the arthritis speedily subside as a result of the complete immobilisation of the fragments there is no

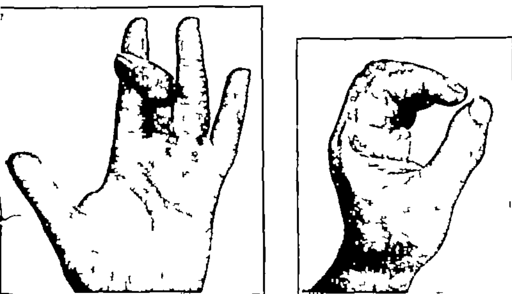


Fig 60 Results of resection of the second articulation of the middle finger

(a) When the other fingers are extended it appears to be inconvenient, but (b) when the fingers are flexed they are all in the same alignment and the finger is useful because the metacarpo phalangeal joint is intact

rise of temperature occasionally lymphangitis of the forearm develops from the second to the fourth day but it clears up with fomentations The temperature chart and the condition of the forearm serve as our guides to the progress of the suppurative focus

The smell of the plaster after ten or twelve days used to be distressing before I commenced to use balsam of Peru In any case the patient must be exhorted to put up with it for a month if possible The plaster is then removed and if a discharging wound should still remain a few ultra violet ray exposures will cause it to heal rapidly

sterile compresses soaked in balsam of Peru are applied unfolded to the resected thumb and covered by a thin layer of sterile cotton wool The dressed finger is then placed on an angled splint applied to its palmar aspect and plaster of Paris covers the lot

The Palmar Splint (Figs 58 (*a*) and 58 (*b*)) The palmar splint may be made either of strong folded iron wire or of a strip of malleable sheet metal about 2 cm broad The surgeon models



Fig 59 (*a*) Resection of the interphalangeal joint of the thumb Splint applied

Over the thumb fixed to the splint, a large dressing has been applied and held in place by a light plaster bandage



Fig 59 (*b*) Resection of the second articulation of the middle finger

The middle finger rests on the angled palmar splint, the end of which is seen projecting through the plaster All four fingers are included in the dressing

it beforehand on his own thumb to give it the exact curves for accurate application In addition to the adaptation curvatures, the splint should be angled so that the two phalanges of the thumb are slightly flexed in the position of function The purpose of the splint is to maintain this position in the plaster So modelled, it is held rigid by a few turns of the bandage, which should be applied just tight enough to hold the finger accurately fixed to the curves of the support

The Enveloping Plaster (Figs 59 (*a*) and 59 (*b*)) Around the thumb thus immobilised a layer of absorbent cotton wool is

slowly It took two months before healing was completed in spite of repeated applications of bacteriophage The final result was bad the terminal phalanx deprived of its flexor tendon was hyper-extended and dislocated backwards by the extensor the other fingers were stiff.

The practical conclusion to be drawn from this case appears to be that conservative operations should be restricted to young and robust patients We have already insisted on this point under operative indications

From the aspect of function the results are invariably good Bony ankylosis never occurs but a strong fibrous ankylosis is formed which permits of slight movement from the start In 1930 in addition to the case described we had operated on six of these arthrites (four in thumb and two in the fingers) with uniformly good results—that is to say with healing in four or five weeks and slight recovery of movements My chief, Moure and my colleagues Petit-Dutaillis and Ch Garnier have given me details of equally happy results Eight successful cases are also included in Cordier s thesis

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Results

The results are excellent and should be assessed from two aspects cure of the suppuration and the functional result (Fig 61) I have only had one failure it was a case of



Fig 61 Late result of a resection of the metacarpo-phalangeal joint of the middle finger for suppurative arthritis

A joint appears to be reconstituted which permits of about 30 degrees of movement

arthritis in a woman aged eighty, in whom resection aggravated the condition

CASE 43 Mme Bou , 80 years In the beginning of August, 1930, she punctured the dorsal aspect of her left thumb with a rabbit bone After several days of acute inflammation chronic suppuration supervened She was sent to me at the end of a month The radiographs showed arthritis quite clearly As "she loved sewing," the old lady insisted that her thumb be saved For this reason I decided on resection by the technique which had, till then, given uniformly good results

On September 5th, 1930, under local anæsthesia, the head of the first phalanx of the left thumb was resected through two small lateral incisions, ether wash out, balsam of Peru dressing and plaster

On September 16th the plaster was removed because the suppuration had spread into the thenar space

September 17th General anæsthesia, palmar incision and dorsal counter-incision Through and through drain—the temperature subsided but the suppuration continued

September 25th The hand was œdematous with fluctuation over the front of the wrist Tendon sheath infection was suspected General anæsthesia Exploration The long flexor of the thumb lay bare in front of the resected joint, a lateral radial incision was made, *the superior cul-de-sac was found distended with pus and* was drained A latero-ulnar incision was added, pus and sloughs were found also in the ulnar bursa, which was opened and drained From then on the suppuration cleared up progressively, though

comprehend that the pus collects in front of the joints as the sheath presents three dilatations separated by two narrower portions The latter are constituted by the long pretendinous aponeurotic bands the pulleys which enclose the tendons in front of the first and second phalanges The tendon there lies in a greatly restricted space within the dense and resistant osteo aponeurotic tunnel where there is no room for pus On the contrary *towards the finger-end in front of the second joint* and especially *in front of the metacarpo-phalangeal joint* there are dilatations in which pus collects After I had myself made this observation I found that Meyer and Hartel (1) had already drawn attention to these facts (and based certain special incisions on them) and Dionis 1745 (2) at a much earlier epoch wrote as follows When the whitlow is of the third variety the pus is not obvious so early because it is enclosed within the tendon sheaths which are covered by very strong ligamentous bands It is usually in the locality of the joints where these ligamentous bands do not exist that a small swelling with fluctuation is observed and opens spontaneously if not incised

The Tendon Sheath Its walls are œdematous and infiltrated the blood vessels are dilated. At operation with a bloodless field they look as if they were injected with tallow This œdema may determine a *functional partitioning* of the synovial cavity I use the term functional advisedly because on two occasions it was not possible to identify any actual adhesion between the tendon and its sheath on dissection at the point of division between the healthy and infected sheath The partitioning as we should expect always occurs in the narrow portions under one of the pulleys the first in my 2 cases In 7 out of 9 cases the cavity of the sheath remained free from end to end while it was interrupted in the other 2 This fact has an important bearing in treatment

The Tendon. Examination of amputation specimens and reparatory operations on the effects of former synovites have shown me that the tendon long resists the infective process in its digital portion in some cases even it may be found absolutely intact *with no adhesions* in its terminal 4 or 5 cm The dangerous point where it shows early change and later destruction is at the level of the superior cul-de-sac in the palm In an old tenosynovitis it is there found adherent and must be dissected from a fibrous mass Above and below this

CHAPTER XIII

DIGITAL TENOSYNOVITIS

INFECTION of the digital tendon sheath constitutes the most serious variety of whitlow, by reason of the irremediable lesions that are caused, the difficulty of treatment, which terminates too often in an amputation, and the danger of rupture of the superior cul-de-sac of the sheath (which runs up for more than 2 cm from the base of the finger into the palm) leading to a deep phlegmon of the hand

They are infrequent of 215 cases of whitlow collected in 1930 we found only 7 , during the first six months of 1931, we saw only 2 cases

Ætiology

The usual cause is direct infection by a punctured or deep wound that involves the sheath, and these comprise the only cases in which operation carries any chance of success Tenosynovitis sometimes occurs as a complication of a subcutaneous whitlow—usually a whitlow of the pulp , in those cases (except when due to a clumsy operation inoculating the sheath) it is always secondary to an osteitis or an arthritis of the finger

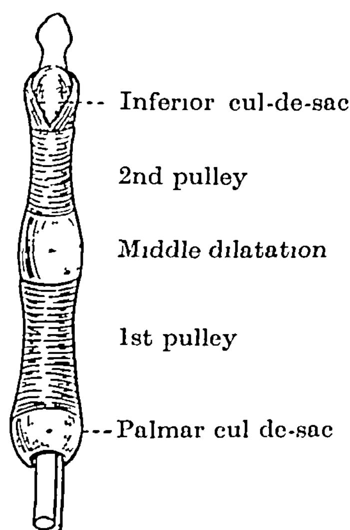


Fig 62 Diagram of the digital sheath Three dilatations are separated by narrower portions which correspond to the pretendinous pulleys of the fibrous flexor sheath

Morbid Anatomy

The Site of Pus This point deserves careful consideration According to the classics, it occupies the whole sheath We agree with Klapp's teaching that the pus, to commence with, is localised to one or two segments of the sheath , complete invasion is secondary or takes place in an irregular manner The anatomical structure of the sheath (Fig 62) enables us to

in only 3 of my last 0 cases As a matter of fact it indicates that *the distension of the sheath* has forced the finger into some flexion the position of maximum capacity but when either spontaneous rupture has taken place at the upper cul-de-sac or distension has been relieved by a small incision into the sheath at any point in its course the finger may be extended with the greatest ease

Moreover the spontaneous or elicited pain does not always extend to the whole length of the sheath but may be localised to the neighbourhood of one of the creases that overlie the joints in front of one of the dilatations, in which pus may collect Dionis drew attention to this fact many years ago In fact the only constant sign, in my experience seems to be *pain on pressure over the upper cul-de sac of the sheath in front of the head of the metacarpal bone* Recently however I saw the following case which presented absolutely no sign of involvement of the sheath.

CASE 44 Vinc 24 years attended Saint-Louis Hospital on April 2nd with definite signs of whitlow of the first phalanx. We waited till April 4th, by which time a well localised collection of pus had formed and then with general anæsthesia and a tourniquet the usual three branched incision was made Pus was found in the first segment with a slight extension to the web Exploration of the focus revealed no other abnormality The wound was packed. In spite of this extensive operation cure was not achieved. Pus continued to discharge and the finger remained swollen and inflamed and according to the patient extremely painful

April 10th A second operation was performed A sinus that led towards the second segment of the finger was opened up and disclosed the tendon which was destroyed towards its extremity and the third joint open and full of pus Amputation was performed without resection of the head of the metacarpal because there was no involvement of the palmar space Examination of the specimen showed that the tendon was intact proximal to the middle of the first phalanx although there was no evidence whatever of obliteration of the sheath by adhesion at this level

In August 1031 two exactly similar cases were seen In short the conclusion we must draw is that *the only certain sign of tenosynovitis is the discovery of the denuded tendon in the depth of a wound that has been carefully explored* under anæsthesia and with a bloodless field

point it is intact What determines this point of election? Probably because it is an ill-nourished point, when the small afferent artery is thrombosed by the infection, but it certainly appears as if the most persistent collections occur at this level when the lesions of the digital canal are obviously cured This observation has greatly strengthened my conviction that the superior cul-de-sac is the site where it is most important to drain

Spread of the Pus. The most dangerous spread is again from this superior cul-de-sac *towards the central retro-tendinous palmar space* to cause a deep palmar phlegmon The pus fills part or the whole of this space in front of the subjacent interosseous muscles which become atrophied or paralysed, so that, after the cure of an infection of even a single finger, the remaining three tend to remain impotent, unless the patient himself re-educates them with energy and perseverance I have only had one case of this kind in my last 8 cases, but two examples of the condition are described on pp 236 and 237

In addition to this deep extension, mention must be made of the lateral spread towards the commissural space and thence towards the back of the hand This *dorsal spread* has long been recognised Lastly, infection particularly of the second joint is, according to Kanavel, by no means an infrequent complication of tenosynovitis My own experience is, however, restricted to two of the third and two of the second joint

Nature of the Pus. As I am not qualified to do so, I have not been able to carry out any personal researches into the bacteriology of these infections The association of streptococci and staphylococci is most frequent, according to the literature on the subject

Clinical Features

The classical signs of tenosynovitis are well defined and consist of very intense pain almost from the start, fever, general malaise, and a semi-flexed finger which it is impossible to straighten This attitude of the finger, considered to be pathognomonic, has been called the "hook" sign (*signe du crochet*) The characteristic shooting pain elicited by the slightest pressure applied at any point over the course of the sheath completes this well-defined picture

In actual practice, the signs are much less clear cut To start with, the "hook" sign is very inconstant, it was present

laying open the sheath from end to end in the mid line The incision extends from the third digital crease below up into the palm for a distance of 2–3 cm The tendon is completely exposed the pulleys are divided any hope of functional recovery is lost and even this mutilation does not exclude propagations and extension tracks The results are deplorable in 1927 out of 18 cases collected 16 had come to amputation within the month following incision This method should be abandoned It is better to amputate the finger right away

The So called Physiological Incisions of Bier They consist in interrupting the long median incision by leaving bridges of skin in front of the joints The tendon remains covered at

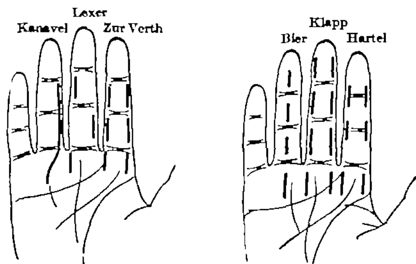


Fig 63 Diagram illustrating the incisions recommended by various authors the most correct from an anatomical point of view are those of Hartel

these points but is exposed under the incisions The results were slightly better Klapp a pupil of Bier conceived the idea of lateralising these interrupted incisions by making them on each side

Klapp s Incisions The sheath is opened without exposing the tendons by eight short lateral incisions two on each segment of the finger and two on the palm down to the superior cul-de-sac It is difficult to understand why this author advocated incisions along the ungual phalanx when the sheath does not extend beyond the second phalanx He appeared however to be satisfied with the results in spite of the fact that the sheath is laid open in places where there is no pus i e at the level of the pulleys and that division of the latter is an essential part of his technique

Evolution

An unrecognised tenosynovitis involves the sheath in its whole length, the cellular spaces of the palm and of the fingers, and the joints, finally, if the whole finger is not destroyed, its tendon at least is condemned and it will leave as a sequel a stiff finger, which if flexed is a tolerable infirmity, but if straight is in general better amputated.

Diagnosis

The difficulty of diagnosis varies in different cases It may be obvious with rapid evolution, direct infection, pain and rigid flexed finger Great difficulty may arise in those cases which have had a previous operation, or in which the involvement of the sheath is secondary to some other variety of whitlow The localisation of the pain to the superior cul-de-sac is a valuable sign, but certainty can only be reached by surgical exploration

In the case of a localised infection where the pus is confined to only one segment of the sheath, a definite diagnosis is very difficult indeed We have described a hitherto unrecognised variety of subcutaneous whitlow, "whitlow of the second phalanx" (*v* p 161), in which the signs are sometimes identical with those of a localised phlegmon of the tendon sheath *Surgical exploration alone, under perfect anæsthesia and with a bloodless field, permits of a definite differential diagnosis by showing whether in the depth of the wound the covering of the tendon is intact* This variety of whitlow is comparatively frequent (16 of 215 cases in 1930), and the tendency of German writers to describe localised tenosynovites that were cured by simple incision of the affected segment may be due to their failure to recognise this particular condition

Treatment

Methods

The methods of treatment are exclusively surgical (Fig 63) Neither phagotherapy nor vaccination with propidon has given sufficiently decisive results to justify their consideration as more than adjuncts The congestive treatment, lauded by Bier and his disciples, has failed in other hands Many varieties of incisions have been proposed

Classical Median Incision. The usual treatment consists in

transformed into sinuses For that reason German authors have introduced certain variations with the aim of keeping them open Zur Verth substituted *elliptical excisions* for the incisions Keppler made use of tiny metal dilators which were held open by elastic bands etc

Kanavel's Incision It is probably for these reasons that Kanavel abandoned interrupted incisions and returned to a lateral incision in the whole of the finger such as Dionis advocated in 1745 in the first edition of his treatise At the base of the finger he extends it upwards towards the mid line to open the superior cul-de-sac It is difficult to understand, with this technique how it is possible to open the sheath and yet avoid injury to the digital neuro vascular bundle which lies in front of the incision in the finger and behind it in the palm Further that author furnishes neither cases nor statistics in support of his method

Personal Technique (3) (Fig 64)

The incisions I recommend *open exclusively the superior cul-de sac of the sheath* That is where the pus finally collects and where the tendon is in greatest danger Further it is there possible to incise the sheath without causing injury to the pulley in front of the first phalanx *In short the synovial cavity might be compared to a thermometer with a capillary tube above and reservoir bulb below If the tube is opened the liquid does not flow but it does so immediately the reservoir is opened*

Cadenat spoke as follows during a discussion on the subject at the *Société de Chirurgie* of Paris on March 23rd 1928

Infections of the finger are extremely serious in spite of the shortness of the sheath and it has always seemed essential to me to carry the incision upwards as high as the distal palmar flexion crease to prevent extension to the palm Is it possible that an incision restricted to the palm only might suffice? The case of Lecène suggests this possibility but here again if it is thought advisable to open the finger as well the lateral incision should there be preferred to the median

The proof that the drainage has been well placed is shown by the fact that the incisions show no tendency to close up so long as pus escapes while any digital incisions previously made dry up and close rapidly as soon as the superior cul-de sac is opened up

The success of this procedure presupposes the absence of

Lexer's Incisions. Lexer made unilateral incisions to avoid complete detachment of the pulley The whitlow was thus laid open by these incisions only The drainage thus obtained is inadequate according to the other German authors

Hartel's Incisions. Hartel's incisions are made on the lateral aspects and where the pus collects Six in number—two crossing the second and third digital creases open the corresponding dilatations of the sheath, while the remaining two are carried down to the superior cul-de-sac From a theoretical standpoint these incisions are perfect but that author has not found support because, in error, Klapp and later Verth accused him of causing injury to the important pre-articular parts of the digital canal Still, anatomy shows that the resistant structures, the pulleys, are in fact *pre-phalangeal*, while there is merely a thin aponeurotic layer in front of the joints

Conservative Incisions. These consist of Klapp's incisions localised to the affected segment. Two, four or six may be made according to the extent of the lesions Their chief defect, in my view, is their failure to drain the superior cul-de-sac, which I maintain is essential The following case, borrowed from Klapp, supports my contention

CASE 45 (Klapp and Beck) An apparently well-localised whitlow of the index finger had been opened by two lateral incisions, along the first phalanx, on January 5th, 1920 The functional and general signs disappeared The wound on the radial side closed rapidly, *but a month later*, on February 3rd, 1920, the incision on the ulnar side was still discharging The tendon sloughed out on the 4th and then healing took place (" Das Panaritium," p 72)

This incision was also employed in the following personal case —

CASE 46 (Summarised) Cour , wound sustained on August 25th, 1930, and widely incised by his doctor on September 1st in front of the second segment As the remainder of the sheath appeared to be intact, cure was anticipated from this operation The suppuration continued however *until four incisions were made in the palm* on September 22nd It then subsided but a sinus persisted till the deep flexor tendon sloughed *Movement of the finger was however conserved by the action of the intact superficial flexor*

All these short incisions have the same drawback the *difficulty of drainage* They always tend to close and become

recognised as it is congested and œdematous *though it may not obviously contain pus* The cul-de sac is opened on each side with a scalpel and the shining pearly tendon exposed There is no danger of injury to the collateral nerves and vessels of the finger because at this level they lie considerably deeper than the synovial cul-de-sac, which lies superficially just under the aponeurosis

A pair of forceps is then inserted through each palmar incision in turn and pushed back to raise the skin on the dorsum the points are then cut down on and opened to grasp a *strip of rubber* or half a small drainage tube (No 18) which is pulled through to project from the palmar incisions It traverses the commissural space from back to front and acts as a drain. The sheath is not directly drained it is simply drained by the two strips, which lie in contact with the opened cul-de-sac

The dorsal incisions are made for two reasons first, to afford *mechanical* fixation of the drain, which when once placed does not shift in contrast to the difficulty experienced in keeping a drain in place in small lateral incisions secondly, *pathological* because of the frequency of dorsal extension of the infection during the post-operative period (this occurs even after a long median incision) if a dorsal incision is not made in the beginning it usually has to be made later This dorsal counter incision either prevents or limits any extension that may occur in spite of it

Before opening the superior cul-de-sac the original infecting wound must be excised The dead tissues are excised with *fine curved and blunt pointed scissors* and at the same time one verifies the involvement of the sheath. This is in fact the only *certain means* of doing so

Post-operative Treatment In only two of our cases pus was not found when the superior cul-de-sac was opened but appeared in this situation a day or two later while the wound of the finger (either the wound or operative incision) which till then had suppurated cleared up and commenced to heal with surprising rapidity

The immediate results of operation are however seldom so simple *Pain* does not disappear till about the third day and the swelling and fever persist for ten or twelve days It is *indispensable* to verify by palpation the condition of the palm in order to detect at once any spread to the deep palmar space (v Case 48) Lastly free *secondary hæmorrhages* took

any partitioning adhesions which, however, do not usually form in *recent infections*, the only cases in which surgical prognosis is favourable Of my 7 cases which were reported by Moure, in only one was the sheath partitioned, and the incisions confined to the superior cul-de-sac were in this case ineffective. In all the other cases, they drained the sheath and effected a cure, the quality of which depended on the state of the finger at the time of operation

TECHNIQUE (Fig 64) General anæsthesia and tourniquet

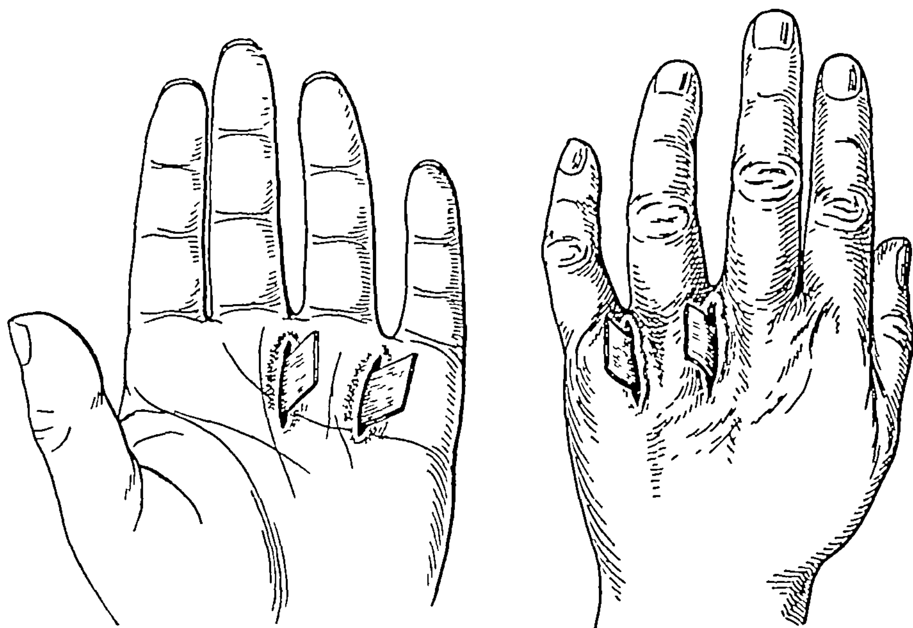


Fig 64 Diagram illustrating my personal procedure Four commissural incisions open the superior cul-de-sac at the site of election and permit introduction of two transfixion rubber strips Alternatively both commissures may be split completely across as advised by Cadenat

The operation comprises four incisions, two palmar and two dorsal, through the commissures

The palmar incisions follow the direction of the intermetacarpal space, opening up both interdigital commissures of the infected finger They average about 2 cm in length and terminate above at the imaginary line that runs from the outer and distal end of the vertical palmar crease to the inner end of the distal palmar flexion crease This line marks the upper limit of the three culs-de-sac of the digital tendons (Kanavel) Below, they do not reach the free edge of the web After the aponeurosis has been incised, the skin edges are retracted to expose the synovial cul-de-sac, which is easily

certainty be inferred and must be dealt with *by dividing the first pulley on one side* the initial portion of the sheath is thereby freely opened

LATERAL SECTION OF THE FIRST PULLEY (Fig 65) One must not forget that the first pulley is long and extends to a high level as it reaches about a centimetre into the palm above the digito palmar crease It cannot be completely divided by merely adding an incision on the lateral aspect of the finger to the existing palmar incision for the upper portion of the pulley will persist and continue to strangle the sheath To effect its complete division *the dorsal route must be followed* by prolonging the existing dorsal incision towards the finger in the dorso lateral line along the line of junction of the palmar and dorsal skin This incision leaves the collateral vessels and nerves intact in the anterior lip of the wound.

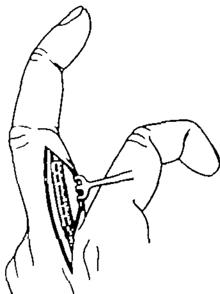


Fig 65 Should drainage of the superior cul-de sac not suffice the first pulley should be divided on one side only after prolonging the dorsal incision downwards into the finger

This large incision permits separation of the fingers the neuro vascular bundle may then be retracted forwards so that in plain view the wide pre-tendinous band may be divided in its whole length close up to its insertion All other methods are fallacious because they do not permit of complete division in its whole extent

Unfortunately as one then finds that the tendon itself is affected and is the underlying cause of persistence of the discharge the functional prognosis is gloomy

Choice of Methods

The indication for operation is quite definite in every case of tenosynovitis and the sooner it is carried out the better The choice of method varies essentially with the particular form of infection

Definite but Recent Tenosynovitis which is still Localised to the Sheath This type furnishes the most favourable indication

place on two occasions, but ceased when the dressings were changed

We would emphasise the importance of *dry and infrequent dressings*, and we are absolutely opposed to arm baths, which are comforting to the patient, but favour *superimposed infection* We have already seen that the tendons resist the streptococcus well but the staphylococcus badly, according to Garlock and Koch The following case is a good example of an early success which was compromised later by secondary infection

CASE 47 Dub , 48 years, sustained a puncture of the front of the proximal phalanx by a piece of broken glass on April 7th, 1931 He attended Saint-Louis Hospital on April 11th, with all the classical signs of infection of the tendon sheath An immediate operation was performed under general anæsthesia "and four incisions were made the superior cul-de-sac was opened and two through and through drains were inserted Exploration of the causal wound showed bared tendon A small amount of pus was found in the superior cul-de-sac" From the second day pus discharged from the hand but continued also from the finger On the eighth day a *secondary hæmorrhage* necessitated his admission to hospital but the bleeding ceased when the dressing was changed On the next day the original infecting wound was closed and the incisions in the hand discharged very little pus One drain strip was removed and then the second The condition was satisfactory with the finger flexed, but the hand remained swollen By mistake an arm bath was given , the patient experienced such relief from this that he removed the dressing and continued the bath in his own home Two days later the finger remained bent Three of the incisions were closed and one only continued to discharge a little serous fluid On the fifteenth day the hæmorrhage recurred but stopped quickly like the first A superficial collection was noted at the base of the fingers and was opened under local ethyl chloride The tendon was then seen to be sloughing and was removed in the hope that only the superficial flexor was involved Unfortunately, the deep tendon also was found to be equally affected Thereafter healing took place rapidly but the finger was useless

If suppuration should persist from the wound (original accidental or operative) in the digital portion of the tendon sheath, in spite of the fact that incisions through the hand have discharged satisfactorily for three or four days, it is certain that the drainage from the superior cul-de-sac is unsatisfactory Partitioning off of the sheath may with

method fall short of this Kanavel must have had a similar experience for he has abandoned discontinuous incisions and returned to the long lateral incision

The results given by my four incisions are excellent but I have only had to treat a small number of cases since the affection is comparatively infrequent During the year 1930 whilst in charge of the out patient clinic at Saint-Louis, which is the largest in Paris, I was able to collect only 7 cases 4 of which must be eliminated as they had undergone antecedent operations that had irreparably compromised the result the remaining three were all treated with success

CASE 48 G aged 12 Tenosynovitis of the middle finger On December 28th he punctured the finger at the second flexion crease with a butcher s knife He showed signs of illness on the next day and the entrance wound which was discharging pus was incised by a doctor without anaesthesia on December 31st He attended Saint Louis Hospital on January 2nd The middle finger was half flexed but could be extended completely without pain A small incision with irregular edges ran obliquely in front of the second phalanx from the level of the second crease the surrounding soft parts were red and swollen while pain was marked over the superior cul-de-sac of the sheath

Intervention under general anaesthesia The four incisions were made the superior cul-de-sac did not contain pus Transfixion drainage strips were inserted. The finger incision was then explored the use of a probe and pressure disclosed a small pocket of pus in front of the joint The edges of the wound were excised and a surface dressing applied

On January 4th fever and local swelling still persisted A subcutaneous collection was present near one of the dorsal incisions which was too short and was enlarged. The condition improved the child was able to flex the finger slept well and had no pain till January 10th when the signs of inflammation reappeared On January 11th the palm was swollen and tender whilst the dorsum was oedematous The diagnosis of infection of the central palmar space seemed certain Under general anaesthesia the inner palmar incision was prolonged to the vertical palmar crease A small artery that bled was tied off Forceps were then inserted into the depth of the palm under the tendons and found the pus A rubber strip was inserted into the space From then on healing took place rapidly and the wound of the finger closed up The drains were removed on January 15th and the wounds closed progressively By the beginning of February healing was complete Re-examined on July 25th both flexion and extension of the finger were normal but

for the conservative methods just described Our incisions, naturally, seem to us to be the best method of treatment, but there are many surgeons who still favour opening the whole length of the sheath I should recommend Hartel's method to them, because the long median longitudinal incision is absolutely condemned, since it fails to prevent complications and always sacrifices the finger It is regrettable that years will pass before it is wholly abandoned

Chronic Tenosynovitis with Involvement of the Tendon Secondary to a Whitlow or to an Arthritis. In such a case it is often difficult to be certain of involvement of the tendon, the exact extent of the lesion can only be revealed by operation The lesions are often too advanced and extensive to leave any hope of a satisfactory *functional* result It is better, without further waste of time, to sacrifice the finger by *disarticulation at the base* when the palmar spaces are not invaded, and by adding *resection of the head of the metacarpal,* in the contrary case

I have, however, had an excellent result in a case of tenosynovitis associated with an arthritis

Results

The quality of the results depends naturally on the extent of the lesions In 4 of 7 cases presented to the *Société de Chirurgie,* the damage caused by antecedent "medical" operations was such as to preclude any hope of cure I operated on them, nevertheless (knowing full well that their condition could not be made any worse), in order to verify the efficiency of drainage restricted to the superior cul-de-sac Except in one case, it was perfectly efficacious

Klapp and Beck lay great stress on the influence of the general condition and especially the *age* of the patient So far as my modest statistics permit, I am able to confirm their opinion Three successes were aged 12, 30 and 35 years, whilst the single failure was 48 years old The German statistics deal with a very large number of cases, and the results are in general excellent Zur Verth reported 28 good results in 50 cases Klapp had 90 per cent good results in 20 cases that were operated on early In his total number of 70 cases, he had three deaths

Unfortunately, in France, the results obtained by Klapp's

method fall short of this Kanavel must have had a similar experience for he has abandoned discontinuous incisions and returned to the long lateral incision

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there was slight stiffness of the third joint from contraction of the median scar on the finger

CASE 49 Ch   Auguste, 38 years Tenosynovitis of the ring finger Attended Saint-Louis Hospital on September 8th, 1930 For two days following a punctured wound he had pain and was unable to sleep He presented the typical signs of phlegmon of the sheath a *rigid hooked finger* symmetrically swollen, pain over the





FIG 66 Ch , aged 38 Acute tenosynovitis of the right ring finger The two palmar and dorsal incisions are shown (Case 49)

superior cul-de-sac with redness and swelling of the commissure that extended to the back of the hand

September 8th Under general anæsthesia the usual four incisions were made, and when the cul-de-sac was opened there was a free discharge of pus from the wound Two transfixion drains were inserted Two days later the swelling had diminished, the finger had become supple and pain had disappeared since the operation

September 12th Slight redness and swelling persisted, but, as there was neither purulent discharge nor pain on pressure, the drains were removed

September 24th Slight dorsal suppuration persisted In the

middle of October the patient on re visiting the clinic was shown to Cadenat who found that there was complete recovery of move ment (Figs 66 67)

Case 50 is equally instructive although the late result was not ascertained

CASE 50 Mme Perl aged 33 Tenosynovitis of the right middle finger

This woman attended Saint-Louis Hospital on April 8th 1930



Fig 67 Ch. aged 38 Tenosynovitis of the ring finger Late result. Flexion is normal (Case 49)

with a small infected wound in front of the third flexion crease which had apparently been explored on the previous day I con tented myself with separating the lips and swabbing out with ether without coming to a definite diagnosis because the finger though swollen was not painful at any point except round the wound and flexion was normal

She returned on April 9th with all the classical signs of teno-synovitis (rigid hooked inextensible finger with pain on pressure over the whole extent of the sheath) Under general anaesthesia

the localisation of the pus was verified by pressure which caused it to exude from the pre-existing incision The four usual incisions were then made Pus was not found in the superior cul-de-sac Two transfixion drains were inserted Next day swelling and pain had diminished although the patient had not slept Pus commenced to discharge from the commissural drains, but ceased from the finger.

April 14th All the signs of inflammation had disappeared The drains were removed The finger flexed perfectly



Fig 68 Phlegmon of the sheath of the ring finger treated by four incisions Result at the end of a month after complete healing Movements are returning

On April 18th the patient was shown to Dr Huet, surgeon to the hospital, because both flexion and extension were now complete The incisions on the finger and on the dorsum were closed, but those on the palm still discharged a little serous fluid

By chance it fell to my lot to operate on no less than 5 cases during the single month of August, 1931 One concerned a man who had sustained a crush of a finger, which had been trimmed and sutured twelve hours later Two days later tenosynovitis of the finger was obvious, the third phalanx was destroyed and could not be flexed, but the second functioned

perfectly Three of the other four cases were completely cured with full recovery of function in less than a month the fourth was a failure because he would not consent to the second operation that I proposed in order to section the first pulley for pus was still discharging from the original wound

In short of eight operations performed on fingers that had not been prejudiced by previous treatment I have had six complete successes and two failures characterised by elimina tion of the tendon Of the last four operated on one is of particular interest for the following reasons two lateral

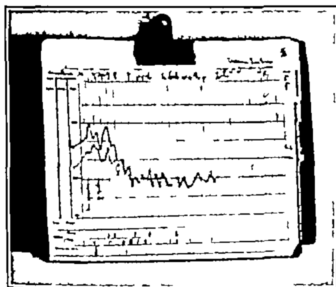


Fig 00 Temperature chart of a patient showing the effect of the four short incisions on the fever

incisions had been made by another surgeon without finding pus the patient was sixty-one years old (this always makes the prognosis bad (Klapp)) and three secondary hæmorrhages occurred from the fifth to the eighth day after operation In spite of these handicaps the result was perfect in five weeks

Since the publication of my technique in the report of Moure to the *Société de Chirurgie* of Paris other surgeons have utilised it with success Tixier Pollosson and Carcassonne presented a patient to the *Société de Chirurgie* of Lyons with the comment that the result confirmed Iselin s ideas I personally have never since that time performed any other operation on a patient with tenosynovitis than the four incisions described above *In young subjects* and in recent

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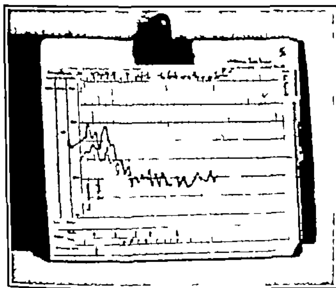


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lesions that have not been subjected to more than one intervention before coming under my care, the results have been excellent, with cure in three or four weeks at the most and with return of full flexion of the finger in less than six months

On the contrary, in patients over forty, and in those who have been treated by other incisions, the prognosis is bad because the tendon always sloughs In those cases in which drainage was unsatisfactory, I have, after division of the pulley in the lateral aspect, been able to establish with certainty that the tendon was involved Consequently *the tendon is not affected because the drainage is bad, but it is the sloughing tendon that keeps up the infection*

The results have been further improved by *complete immobilisation of the finger* till the tenosynovitis is cured Immobilisation and infrequent dressings are of prime importance

Gellé (4) sums up the matter as follows "The opening of digital tenosynovitis at the metacarpo-phalangeal cul-de-sac is justified on anatomical (structure of the fibro-synovial tendon sheath) and physiological grounds (natural position), by the pathological anatomy (presence of pus in this situation and its absence elsewhere in the sheath), and by the excellent clinical results obtained by the method "

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CHAPTER XIV

ANATOMY OF THE CELLULAR SPACES OF THE HAND

THE anatomy of the hand and of the fingers has long formed the subject of many researches Still, these have been concerned only with structures which in comparison with the cellular tissues we might term the noble structures of the hand. The muscles tendons aponeurotic structures and the synovial sheaths have been the subject of so much study till it seems that to-day further study could add but little to our knowledge concerning them The cellular tissues on the contrary seem to have been forgotten and almost wholly neglected

Is this lack of interest justified ? Indeed from a purely anatomical standpoint they appear to have a very secondary role in the architectural constitution of the hand and in the classical view they are regarded merely as packing The surgeon however is aware that they are sometimes the sites of purulent collections that are distinct from infections of the tendon sheaths and that are designated phlegmons of the cellular spaces of the palm (Raymond Dubau) (1)

ANATOMY OF THE CELLULAR SPACES

The standard works on anatomy make mention of the presence of cellular tissue around the noble structures of the region but do not emphasise the fact that those cellular planes constitute definitely limited and constant spaces Kanavel s great merit was that he did not rest content with a dissection that completely upsets the relations of the structures in the region since it either removes the cellular tissue in order to clear up the dissectable structures (aponeurosis tendons muscles nerves etc) or exposes the cellular tissue by excising these structures He conceived the plan of *injecting* these spaces with liquid plaster which when set preserved its form and

thereby permitted precise study of its relations on subsequent dissection

Thus he was enabled, in 1904, to describe a retro-tendinous space, which he called the "middle palmar space" and which could be filled up from the ruptured superior cul-de-sac of one of the tendon sheaths, if that structure was distended at high pressure through an incision in front of the first phalanx Kanavel described the limits of that space as follows (Fig 70)

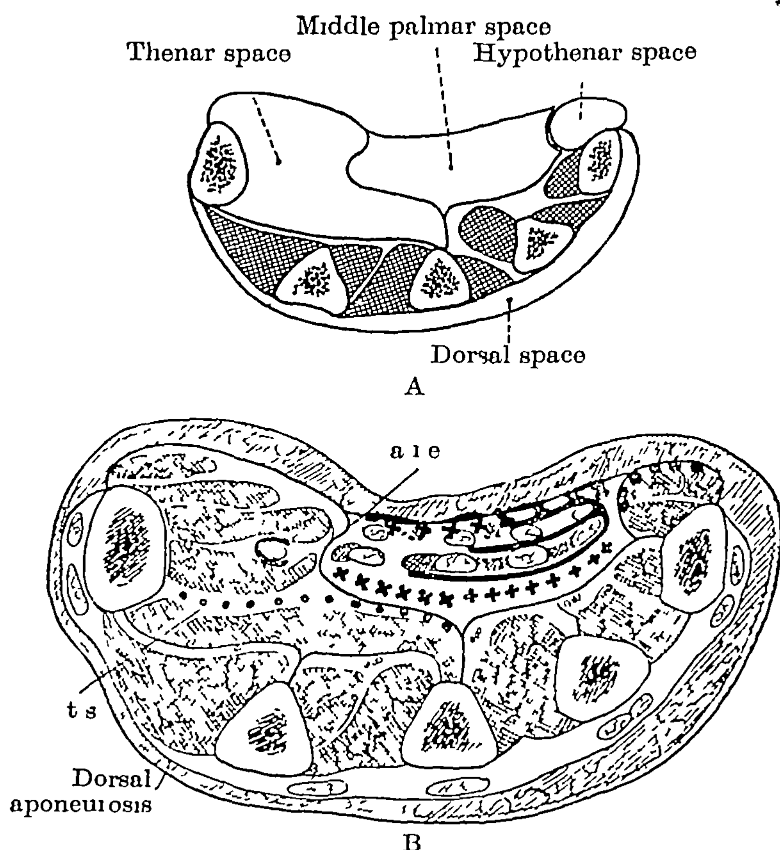


Fig 70 A Spaces of the hand B The cellular spaces of the hand

t s, thenar space, a i e, external intermuscular aponeurosis, +, median retro-tendinous palmar space as delimited by Kanavel, X, the same space, as I conceive it, extends to a i e, X, the superficial middle palmar space in front of the tendons, , the hypothenar space

behind, the deep palmar aponeurosis overlying the interosseous muscles, *in front*, the posterior aspect of the flexor tendons and lumbricals and the extremity of the ulnar bursa, *on the medial side*, the internal intermuscular partition, which separates it off from the hypothenar space, *laterally*, a thin fibrous sheet which separates it from the thenar space and which lies in front of the third metacarpal *Proximally*, it is closed by

adhesion of the sheath of the ulnar bursa to the anterior aspect of the wrist joint *Distally* a complete series of fibrous structures converging on the heads of the metacarpals form a real barrier

This barrier is pierced by two orifices for each finger, by which communication is established between the fingers and the palmar space (Fig 71) One of these communications is the *digital sheath* the superior cul-de sac of which reaches the space it lies in front of the metacarpal bone the other is

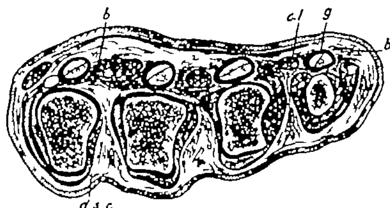


Fig 71 Section through the heads of the metacarpals (after Kanavel) In front the fibrous barrier (b) pierced by sheath (g) and the lumbrical. In front of each metacarpal is the lumbrical canal (c.l.) Behind the dorsal subcutaneous cellular tissue (d.s.c)

inter metacarpal and gives passage to the *lumbrical* and the corresponding neuro vascular bundle The cellular tissue is reduced at this level to a thin layer that surrounds the small muscle as far as the base of the finger and it is this *lumbrical prolongation that forms the only way of communication along which cellular infections pass from the finger towards the hand* Lastly the American author believed that only the sheaths of the middle and ring fingers communicated regularly with the central palmar space the index communicating more often with the thenar space Moreover on forcing the injection with sufficient pressure it was possible to break down the barrier between the central palmar and thenar spaces the rupture being always situated in the upper part of the space

In 1927 I repeated Kanavel s experiments in the laboratory of Professor Hovelacque (2) filling the median palmar space by forced injection and rupture of one of the digital sheaths I verified thereby the situation of the space but to my great

surprise, its outer limit did not coincide with that given by Kanavel, that is to say, with the third metacarpal, the injected material always surpassed it and spread to the second, as is shown in the radiograph. And, although the film was exactly comparable with that given by Kanavel, as typical of spread from the central palmar to the thenar space, *my dissection showed that the plaster had not emerged from the space under study, but remained separated from the thenar space by a wholly intact external intermuscular aponeurosis*. Injections with barium confirmed these limits and showed that the central palmar space occupies the whole extent of the central palmar space as defined by anatomists, *i.e.*, it extends behind the tendons, from the internal intermuscular aponeurosis to the vertical portion of the external intermuscular partition. In final proof, injections forced through the sheath of the index never reached the thenar but usually entered the central palmar space; moreover, as the tendon of the index traverses the central palmar space in its whole length, it was difficult to understand how an anatomical communication could be established between its sheath and the thenar space.

The same investigations were repeated in 1928 by Dubau, Assistant in Anatomy to the Faculty of Toulouse, who sought to explain the divergencies of opinion between Kanavel and myself by the existence of a layer, the sheath of the second lumbrical, which separated off a space for the index. As we shall see further on, this layer and space do exist, but do not serve to explain the difference in opinion. Moreover, Dubau's text lends support to Kanavel while his illustrations confirm my opinion.

In 1930 I was able to collect 28 cases of infection of the palmar spaces at the out-patient department of Saint-Louis Hospital. In two only was the central retro-tendinous palmar space involved, whilst all the others had invaded those spaces which Kanavel described as small and badly defined ("imperfect spaces round the tendons, particularly anterior to them") and which form the *pretendinous superficial middle palmar space* and the *commissural spaces*. The anatomical study that I have carried out with my friend Évrard (3) in the laboratory of Professor Hovelacque served to show that these spaces are in fact as well defined and as characteristic as that of Kanavel.

Later, Cordier and Coulouma (4) and Russell Best (5) have restudied the question from the anatomical standpoint. As

pure anatomy seems to lack interest in an essentially practical question and as their studies add nothing further to the description of infections of the palmar cellular spaces given by Évrard and myself, we shall not comment on them Their intrinsic merit is, however considerable They are given in detail and discussed in Gelló s thesis

Methods of Study

We at first tried gelatine injections, but gave it up because we found that it diffused much too easily though it was convenient because the injection could be made with an ordinary needle We returned to the use of sufficiently fluid plaster for dissection specimens and to barium injections for radiography

The injection is made directly into the space under study, if need be under the control of a small skin incision which permits of exact *definition of the anatomical relations* These studies carried out on twenty-eight hands enable us to describe *six spaces* including the four already accepted palmar spaces

In the central palmar region there are three —

The superficial pretendinous palmar space

The deep retro-tendinous palmar space (Kanavel)

The commissural spaces

The thenar space in the thenar eminence

The hypothenar space in the hypothenar eminence

The dorsal space on the back of the hand

We now proceed to describe these spaces in detail with their respective boundaries and the lines along which spread from them have been observed experimentally

(1) The Central Superficial Pretendinous Palmar Space

It is limited as follows (v Fig 70) —

In front the palmar aponeurosis a thick layer of subcutaneous cellular tissue and the skin

Behind the front of the tendons the lumbricals the vessels of the superficial palmar arch and the nerves (which however on two occasions lay in front of the mass of plaster)

External boundary lies along the line of the second metacarpal sometimes even in the second inter metacarpal space and is formed by union of the *middle palmar aponeurosis* with the external intermuscular aponeurosis

Internal boundary lies along the fourth inter metacarpal space

and is formed by union of the hypothenar aponeurosis with the middle palmar aponeurosis

The upper boundary is formed by union of the palmar aponeurosis with the flexor retinaculum, in front of which the superficial palmar space communicates with the forearm



Fig 72 The superficial central palmar space injected with barium Diffusion is better than with plaster The digital extensions and the extension into the forearm are well shown

The inferior boundary is formed by fusion of the middle palmar aponeurosis with the superficial transverse ligament described by Poirier (the transverse fibres of the palmar aponeurosis)

In addition, there are, in the distal third of the palm, several



Fig 73 Injection of plaster into the superficial central space showing its connection with the forearm extension. Above injection into the commissural space.

dense fibrous partitions which run in the sagittal plane (Legueu and Juvara) and unite the deep aspects of the middle palmar aponeurosis to the deep interosseous aponeurosis These partitions do not exist in the upper two thirds of the

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Behind by two distinct fibrous structures the deep palmar so-called interosseous aponeurosis and lateral to the anterior border of the third metacarpal by the inner horizontal portion of the external intermuscular aponeurosis outside that bone

On the outer side by the external vertical portion of the external intermuscular septum

On the inner side by the internal intermuscular septum



Fig 75 Radiograph of the deep middle palmar space injected with barium.

Compare Fig 72, which represents the superficial palmar space similarly treated Its shape, size and especially the four lumbrical diverticula are shown. The latter run beside the tendons as far as the lateral aspect of the fingers. It is to be noted that the commissural spaces, which are anatomically independent, are not injected.

Above the space ends with the cellular tissue at the level of the wrist joint

Below it is limited by the fibrous barriers stretched between the metacarpo phalangeal articulations

The space is subdivided in its inferior part by the sagittal fibrous partitions of Legueu and Juvara into four little diverticula one for each finger The diverticulum for the index (Delorme) is the most important because it is more distinct than the others its outer limit extending higher into the palm (Fig 74)

palm where the block of plaster forms a homogeneous mass, whilst, on the contrary, it is cut into by them in the inferior part

Its communications are as follows —

With the forearm, by the gutter of the ulnar artery The injection runs up to a degree that varies with the force of injection Of ten superficial palmar spaces injected, this spread was extensive in three and slight in four (Fig 73)

With the first commissural space, by pushing back the external



Fig 74 Plaster injection into the deep retro-tendinous central palmar space The flexor tendons have been divided to expose it

The shape of the space is seen It is divided in its lower portion into four little diverticula that of the index (Dubau) being separated off high up from that of the middle finger by a cleft, which represents the aponeurotic partition that divides them The two intermuscular partitions, external and internal, are seen retracted by forceps (M Iselin)

intermuscular partition, which, if it remains intact, prevents spread into the thenar space

Lastly, with the retro-tendinous space, when the injection is forced under high pressure In 4 cases, this communication took place between the tendons of the index and medius, and once, around the outer side of the tendinous bundle

(2) The Deep Central Palmar Space

It remains as described in 1927.

It is bounded (Fig 70) —

In front, by the flexor tendons and their sheaths

Laterally by adhesion of the skin to the pretendinous digitations of the palmar aponeurosis

Above by adhesion of the skin to the transverse fibres of the palmar aponeurosis

Experimentally no spread could be effected either to the neighbouring commissural spaces or to the dorsal aspect of the hand

(4) **The Thenar Space** is limited as follows —

In front by the thenar or intermuscular aponeurosis which is attached to the third metacarpal (Fig 70)

Behind, by the transverse head of the adductor pollicis

Laterally by the first metacarpal covered by the thenar muscles

The exact site of the plaster mass lies between *the two heads of the adductor pollicis* Experimentally no spread into any other space could be reproduced

(5) **The Hypothenar Space**

It is quite well limited on all sides by the hypothenar aponeurosis which commences on the external border of the fifth metacarpal and terminates on the ulnar border of the same metacarpal

(6) **The Dorsal Space**

Elongated in a longitudinal direction, it is limited —

In front by the extensor tendons united together by a thin fibrous layer

Behind by the superficial dorsal aponeurosis and the skin

On the outer side by fusion of the superficial dorsal aponeurosis with the dorsal interosseous aponeurosis

On the inner side by the insertion of the superficial dorsal aponeurosis to the fifth metacarpal

Above by union of the dorsal aponeurosis with the extensor retinaculum

Below by fusion of the superficial aponeurosis with the fibrous sheaths of the fingers

Experimentally there was no communication with either the sheaths or any of the other spaces

This anatomical study leaves us with certain problems for which it offers no solution.

Spread from the Pretendinous Palmar Space into the Thenar

Its communications are (1) *By the lumbrical prolongations* with the fingers, when the injections are strongly forced

(2) *With the thenar space,* as soon as the spread of the plaster has broken through the external intermuscular septum

(3) *With the forearm*, by insinuating itself along the tendons under the flexor retinaculum, but always remaining posterior to the sheaths

(3) The Commissural Spaces (Fig 76)

Three in number, they are situated above the interdigital commissures and limited —

In front, by the skin

Below, by the skin of the web and by the interdigital palmar

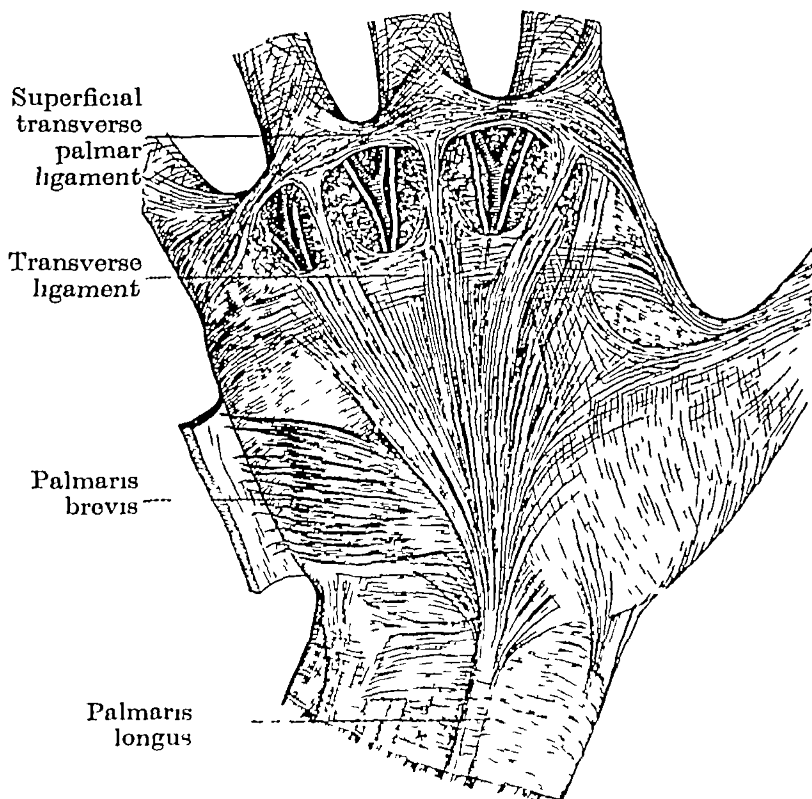


Fig 76 This classical diagram shows the three commissural spaces between the transverse fibres of the palmar aponeurosis (transverse ligament) and the superficial transverse palmar ligament separated by the pretendinous slips of the palmar aponeurosis (After Poirier)

ligament of Legueu and Juvara (superficial transverse palmar ligament)

Behind, by the deep dorsal aponeurosis reinforced at this level by the superficial dorsal aponeurosis

CHAPTER XV

PHLEGMONS OF THE CELLULAR SPACES OF THE HAND

THE site of pus formation in infections of the cellular spaces just described has given rise to much dispute No assistance in this respect is gained from the writings of the *older authors* since their observations were chiefly based on autopsy material From the writings of Chassaignac and Dolbeau we learn that pus diffuses widely and that in the circumstances it was quite impossible to ascertain its initial localisation thus Chassaignac drew no distinction between infections of the sheaths and those of the cellular spaces (1)

The question that preoccupied those authors was the route of spread of infections from the fingers towards the hand and forearm they recognised that these spreading infections which were frequently fatal at that time were usually caused by a whitlow Velpeau clearly appreciated and taught that spread from the fingers towards the hand could take place by three possible routes along the tendon sheaths, by the cellular planes and by the lymphatics This opinion has regained favour at the present time Later Dolbeau and Chevalley (2) drew no distinction between the lymphatic and cellular routes and denied the importance of the synovial spread In their view if the infection followed the sheaths it did not pass along the synovial cavity but by the peripheral lymphatics It is of interest to note that this theory was supported even quite recently in Samière s thesis (3) and one of the clinics of the Faculty of Marseilles sought to prove that whitlows of the thumb and of the little finger unlike the other fingers never gave rise to phlegmon of the hand Against these assertions Gosselin and E Schwartz (4) emphasised the importance of purely synovial infections and the great liability of spread to the palmar sheaths from the thumb and fifth finger because of the constant communication which exists between these structures These authors considered that tenosynovial infections were the commonest and most serious and that if

Space This frequently occurs clinically, although the existence of any communication has never been established experimentally On one occasion only, we observed that the external intermuscular aponeurosis had been pushed outwards by the plaster without, however, any invasion of the space. Is it possible that, in the living, communication is established along the thenar branch of the median nerve or the superficial palmar branch of the radial artery ? We are not able to reply

Spread from the Commissure. (1) *Towards the Dorsal Space* It is probably due to communication through the lymphatics It has been established that the lymphatics coming from the palmar commissures run by a recurrent course towards the dorsal collecting vessels We have been able to verify this fact

(2) *Towards the Neighbouring Commissural Spaces* This undoubtedly occurs clinically but we have failed to find the route of this spread

Spread from the Lateral Aspect of the First Phalanx. We have failed to demonstrate communication along the cellular tissues The spread is doubtless through the lymphatics, since we have been able to cause it by injection of the lymphatics in this region

Lastly, it may happen that a **small wound of the lateral aspect of the first phalanges of the fingers** may determine a suppurative arthritis of the wrist joint There is, however, no direct communication We have, therefore, tried to find lymphatic communication The lymphatics of the upper limbs of fourteen full-time fœtuses were injected with Gerota's blue and then dissected We have found lymphatic trunks running in close relation to the radio-carpal articulation but no direct communication with the joint could be demonstrated

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3 M Iselin and H Lavarde "Étude anat des espaces celluleux de la main" (*Ann d'Anat Pathol*, t IX, pp 37–62, Jan, 1932)
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5 Russell Best "Anat and clin study of infections of the hand" (*Ann of Surg*, March, 1929)

The sixth variety is dorsal In this we differ greatly from Kanavel who considered only one central palmar space—the posterior retro tendinous—to be of interest both anatomically and clinically From a general consideration of the various works we find that the English writers have accepted the ideas of Kanavel Zur Verth (7) and Rehn have also done so We have been agreeably surprised however to note that Klapp and Beck have arrived at results similar to our own

PHLEGMON OF THE THENAR SPACE

The thenar space being well defined its infections assume a very characteristic clinical aspect which has for long led to their recognition

Their *frequency* (comparative) is 7 cases seen in 1930 The *ætiology* varies 2 cases followed a subcutaneous whitlow of the thumb 2 were secondary to tenosynovitis localised by adhesions to the digital portion of the flexor sheath of the thumb whilst in 3 no precise cause was apparent The *pus is located* in the palm anterior to the transverse head of the adductor pollicis It spreads towards the web and from there may reach the dorsal aspect In one case only the infection was restricted to the dorsum

The functional and general *signs* are those of a serious infection The physical signs are characteristic The thenar region is markedly swollen on both its palmar and dorsal aspects but this swelling ceases abruptly at the adductor crease of the thumb and the remainder of the palm is flat supple and painless Palpation elicits intense pain on pressure over the thenar eminence and over the web which is so red and swollen that the thumb is held abducted by the swelling

The *evolution* is slow if the cellulitis is *symptomatic* of a tenosynovitis localised by adhesions Such a case has usually been preceded by a serious whitlow of the thumb followed by progressive swelling of the commissural space In such a case too cure does not follow simple drainage in our 2 cases a second operation revealed the tendon in process of necrosis and lying exposed in pus cure followed its removal (i Case 05 p 239) In the more habitual case of *idiopathic* infection, the signs reach a maximum in three or four days and recede after incision Cure seldom takes more than about a week

Treatment The collection i incised under general

pus should also be present in the cellular spaces, it was invariably secondary to rupture of the synovial sac

Since 1904, Kanavel, in America, has studied the cellular spaces of the hand and shown that infections do occur in these spaces, and that, to start with at least, they may be restricted to these spaces with no involvement of the sheaths Of these cellular infections, one variety, that of the thenar space, had long been recognised as the *commissural phlegmon of the thumb (associated with the name of Dolbeau)*, but to my knowledge, the deep extra-synovial infections of the cellular spaces of the palm were not identified until the works of d'Altemaire, Bovis, Forgue and in particular the article of Picqué (5) *clearly and precisely described* this particular variety of deep extra-synovial infection, which developed in the retro-tendinous cellular tissue Picqué also advocated certain incisions planned to open the deep collections of pus *without injury to the intact sheaths* This is the first time, in the French literature, that care in this respect was advocated with such precision Later works are much less exact in their divisions, they include the theses of Sanière and of Kerjean (6), the latter being entitled "Systematic incisions for the serious phlegmon of the hand," as if there was only one variety of serious phlegmon in the hand

We must draw an absolutely clear distinction between infections of the tendon sheaths and those of the cellular spaces, tendon sheath infections are much more serious, while infections of the cellular spaces are more frequent and may spread to the sheaths if the collection is not recognised early and opened up before it has had time to spread and involve other structures Such early operation demands an exact knowledge of the anatomical site, of the clinical signs and of the appropriate incisions that expose and open the collections without risking dissemination These precise facts can only be acquired by early operations carried out under general anæsthesia and with a bloodless field, which permit of careful surgical exploration of the collection in its whole extent and of any possible extensions

We have, therefore, been led to describe six varieties of cellular infections of the hand that correspond with the spaces described on p 217 *Five of these are palmar* one thenar, one hypothenar and three in the middle compartment (one pretendinous, the second retro-tendinous and the third inferior commissural)

The sixth variety is dorsal In this we differ greatly from Kanavel who considered only one central palmar space—the posterior retro tendinous—to be of interest both anatomically and clinically From a general consideration of the various works, we find that the English writers have accepted the ideas of Kanavel, Zur Verth (7) and Rehn have also done so We have been agreeably surprised however to note that Klapp and Beck have arrived at results similar to our own

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clinical findings We have seen on p 214 that to fill this space opaque fluid must be forced into one of the digital sheaths till it bursts to fill the space In only one case was infection secondary to a metacarpo phalangeal arthritis but there also the sheath had certainly been invaded before the palmar space The *tenosynovitis affected the middle finger* in four and the index in one of these cases

The Site of the Pus The pus is situated in the retro-tendinous space *but it does not necessarily fill it completely* In 2 cases in which the infection originated in the middle finger the infection remained median and did not involve the inner and outer parts of the space In the other 4 the space was completely invaded Dubau and Aboulker have observed cases in which the *phlegmon was confined to the index space* and thus only involved the small outer space

The amount of pus varies but is never large in amount about a thimbleful being the maximum quantity It is often spread out as a thin layer over the space and signalises its presence by a sign which we regard as very characteristic—*paralysis of the interossei* These muscles lie immediately under the pus and are therefore picked out and remain paralysed for a long time After the period of suppuration, trophic troubles of the fingers become manifest as a result of irritation of the nerves and vessels in their palmar course

Lastly I have on one occasion only seen a definite lumbrical spread such as we were able to obtain experimentally This is no doubt due to the circumstance that all our cases were diagnosed and operated on at an early stage

Clinical Features We describe the commonest variety the one complicating a tenosynovitis that has already been operated on The temperature and swelling do not subside or reappear after a temporary improvement The pains alter in character, becoming dull and localised to the palm The swelling is visible on inspection and is associated with redness of the median part of the palm Swelling is most obvious towards the commissures and on the dorsum of the hand. Flexion of the fingers is not marked but active movements are painful. The wrist is freely movable and the forearm normal. Intense pain is elicited by palpation over the whole of the middle of the palm and sometimes pressure thereon causes a little pus to exude from the drainage incision of the tenosynovitis

Progress after operation is in general favourable The

anæsthesia, but there is no need for a tourniquet One of two methods may be chosen The *classical incision* made along the free fold of the web may be carried in depth towards the palmar aspect or on the dorsal side to open the collection and the commonly occurring dorsal extension and a drain inserted into both Kanavel who considers that this method has the disadvantage of leaving a scar which is liable to retract and restrict abduction of the thumb, prefers a palmar incision over the front of the collection with an added dorsal counter-incision and a transfixion drain I, too, have observed this troublesome sequel in one case and have, since then, also employed a through and through incision

PHLEGMON OF THE HYPOTHENAR SPACE

Of *infrequent* occurrence I have only seen 3 cases one only during 1930 The *ætiology* was not obvious in one case, the second was caused by a punctured wound from an iron splinter, and the third developed beneath a *callosity* on the hypothenar eminence (a callosity which, according to the patient, is frequent in shoemakers)

The *pus is localised* between the hypothenar muscles and their aponeurosis, and completely fills the space The *signs* are characteristic intense pain (the space being inelastic), redness, swelling and tenderness, which are all restricted to the hypothenar eminence

Treatment. Under general anæsthesia the eminence is incised and drained by a strip of rubber Healing takes place in less than seven days

PHLEGMON OF THE RETRO-TENDINOUS CENTRAL PALMAR SPACE

This, according to Kanavel and Picqué, is the most common and characteristic site of infection, they do not, however, give any detailed statistical or ætiological study of it *Personally, I have only seen six examples of it, three of which were observed in* 1930

The ætiology of five of these cases was, as is customary, a digital tenosynovitis that had burst at the superior cul-de-sac. There again experimental anatomy is confirmed by the

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Progress after operation is in general favourable The

infection spread to involve the ulnar bursa in only one, the very first of our cases All the others recovered more or less quickly after operation In one case, recovery was complete, but all the others developed paralysis of *all the interosseous muscles*

Sequelæ. The appearance of the affected hand is very characteristic (Fig 77), with the first phalanx extended, while the second and third are flexed but not to a marked extent The fingers are greatly deformed by considerable swelling of the second joint, which is always enlarged in size The skin



Fig 77 The appearance of the hand affected by paresis of the interossei following phlegmon of the deep palmar space consecutive to tenosynovitis of the ring finger

The middle and little fingers are chiefly affected their second and third phalanges semiflexed, the first extended, and only slight movements are possible

desquamates and later changes in character to assume a "trophic," smooth and shining appearance Spontaneously painful alternate with anæsthetic zones The action of the flexor tendons is always seriously affected , the first and then the second phalanges become stiff, so that a few degrees of flexion can only be elicited with difficulty in the second and third joints The determination of the presence of even a slight amount of movement is important, because then, if the patient works with method and perseverance, *complete functional recovery may be expected* In general, about six months of daily exercises are required to secure a good final result

Diagnosis. Diagnosis is based essentially on the per-

sistence of the general signs and of the pain the appearance of œdema of the back of the hand and of a median swelling which is painful on pressure

Infection of the thenar space is easily recognised by its special characters and strict localisation to the thenar space Quite special signs are caused by *tenosynovitis of the radial and ulnar bursæ* apart from the hooked finger which is unreliable as we will show the spread of signs into the forearm and the pain diffused over the whole extent of the sheath easily permit of differentiation We must however, recognise that a deep cellulitis may follow rupture of an infected ulnar bursa with signs such as we have described but overshadowed by those of the tenosynovitis The very characteristic attitude of the hand shown on p 230 is attributable to a spread of this kind towards the cellular spaces We have never observed this complication since we began to employ interrupted and lateralised incisions

Lastly differentiation of the deep retro-tendinous phlegmon from the *commissural variety* to be presently described is easy for in the latter the hollow of the palm remains perfectly normal and all the signs *e g* pain and swelling are localised to one or several of the web folds

Treatment

Methods

The operative methods are two in number *drainage of the collection* by incisions that avoid injury to the sheaths and that were described by Picqué and Kanavel *amputation of the finger in which the infection originated with resection of the head of the corresponding metacarpal bone*

Indications for Operation

As soon as the diagnosis has been made it is necessary to intervene with if one wishes to be conservative general anæsthesia and an Esmarch bandage but when amputation is intended the latter is unnecessary The choice of method is determined essentially by the condition of the finger in which the infection originated because if its function is impaired it is useless to try to save it

The tenosynovitis has already been operated on by a destructive median incision which has failed to prevent the

appearance of a phlegmon of the hand In such a case the function of the finger has certainly been destroyed and the only course lies in amputation, to which, in my opinion, *resection of the head of the metacarpal should be added,* because, if left, it acts as a plug which blocks from below the infected spaces The value of this resection has been greatly discussed: favoured by some for æsthetic reasons, it is rejected by others for mechanical reasons, or from fear of osteitis (Klapp and Beck) Lecène and Huet state, with reason, that the neighbouring fingers approximate, turn towards each other and meet in flexion, moreover, the grasping surface of the hand as represented by the heads of the metacarpals is diminished

In my opinion, resection of the head is an operation of *necessity* and not of choice Its removal is essential to establish efficient drainage of the infected spaces, which it plugs For that reason, its removal must be restricted to serious infections that have spread to the palm, and it should never be done in injuries In 2 cases, serious trouble resulted because I had omitted to carry out this resection

CASE 51 Mau , aged 47, engineer From a small wound of the index finger sutured elsewhere tenosynovitis developed and was incised in the middle line The condition became worse and the patient consulted Dr Moure, who sent him to me

It was obviously useless to try to save the finger, and it was disarticulated at its base In spite of that the temperature kept up with pain and swelling of the palm Pressure in the middle of the palm caused pus to exude, and the fingers assumed the attitude typical of paralysis of the interossei with increasing rigidity Five days later the head of the metacarpal was resected and the wound left open From then on the signs of infection subsided and healing took place slowly

In contrast to this, all our other cases in which the head of the metacarpal was resected early progressed favourably and only one developed tenacious osteitis of the divided end of the metacarpal

The Phlegmon has no Apparent Cause (This eventuality is possible according to numerous writers, though *I myself have no experience of it*) It is sufficient to drain the collection by a well-placed *incision to effect a cure* *Pequé recommends* two incisions and drains on either side of the ulnar bursa The technique is difficult because nerves or arteries may be wounded (with subsequent danger of secondary hæmorrhage), more-

over, drainage is defective because the vertically placed drains lie in contact with the sheath I have never adopted this method for these reasons and because Kanavel s is simpler and more rational (Fig 78) His method consists in making an incision through the inferior portion of the interdigital space along the lumbrical muscle The incision can if necessary be prolonged upwards for 3 to 4 cm into the palm Pus may then make its appearance but in any case a pair of *closed* forceps should be passed up under the tendons into the retro-tendinous space and then opened to evacuate the pus A strip of rubber in this incision gives perfect dependent drainage without endangering any other structure except perhaps the rather inconstant superficial palmar arch.

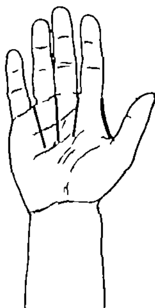


Fig 78 Incisions for phlegmon of the deep central palmar space.

Incisions along the lumbricals give access to the deep palmar space under the tendons. *On the right* the commissural incision for phlegmon of the thenar space is shown.

The causal tenosynovitis has been correctly treated by lateral incisions as described on p 201 It suffices to prolong one of the lumbrical incisions upwards into the palm and to seek the pus under the tendon The treatment is exactly the same if the case is one in which the tenosynovitis has not been operated on though I myself have never seen a case of this kind

The Collection does not Occupy the Whole of the Median Palmar Space as a Rule it is then Confined to the Index Pocket Dubau incises the web recognises the grey infiltrated lumbrical space prolongs the incision into the palm and pushes a pair of Kocher forceps up along the tendons pus escapes when the jaws of the forceps are separated A strip of rubber is substituted for the forceps and the case is then treated with the hand kept in a dependent position

Results

Two only of my 6 cases were treated by Kanavel s incision. In one the result was excellent in the other the ulnar sheath became involved In the other four the digital lesions were

so far advanced that disarticulation with resection of the head of the metacarpal was obligatory In one of these, already described, resection of the head was secondary

The late results were as follows in one case, rapid cure with complete recovery after incision , in a second case, the result was satisfactory despite the fact that a sheath infection was operated on much too late by a lateral incision , in four there was interosseous paralysis with trophic troubles Two of the latter co-operated with vigour and completely regained their movements , the other two were less energetic and one partially recovered, whilst the other had permanent incapacity

Conclusion

The deep palmar phlegmon does not, in my opinion, merit the interest bestowed on it by Kanavel and Picqué It is uncommon, and as it is invariably secondary to tenosynovitis, it should be regarded as a complication of this particular type of whitlow rather than an autonomous condition

Cases

Localised Phlegmons of the Deep Central Palmar Space

The following are typical cases of phlegmons localised to one part or another of the deep central palmar space —

CASE 52 *Localised phlegmon of the deep central palmar space (ring finger diverticulum), with spread to the ulnar bursa*

Sen , aged 24, was wounded by scissors on May 24th, 1928 Two days later, treated elsewhere by a median incision which was placed in front of the first phalanx of the ring finger and which exposed the tendon Attended the out-patient clinic of Lecène on May 28th Inspection revealed swelling and redness of the palm with great local œdema There was diffuse pain over the centre of the palm but the eminences were painless The fingers were semi-flexed—the fifth could be extended, the incised fourth was extended, the third slightly less painful, while the second was normal

Intervention on May 28th General anæsthesia with ethyl chloride and Esmarch bandage Two incisions were made in the third and fourth spaces in the line of the lumbricals On pushing forceps into the deep palmar space and opening them a fair quantity of pus escaped There was none in the fourth intermetacarpal space Two small exploratory incisions at the back of the hand found no pus, and a small incision towards the proximal part of the

palm (*le talon de la main*) was also made with a negative result Two rubber strips were introduced through the lumbrical incisions

Progress Suppuration persisted for eight days and after being normal for seven days the temperature rose again. On the seventh day a superficial collection appeared on the front of the wrist but the fingers remained supple and could be extended without pain This in Lecène s opinion excluded the possibility of common flexor sheath involvement and on his advice the case was treated by a simple incision over the point of maximum fluctuation but no pus was found

On June 9th the redness and swelling of the forearm had increased and there was a rise of temperature Pressure on the forearm caused pus to exude freely from both the wrist and palmar incisions The ulnar bursa obviously contained pus

Intervention under general anæsthesia A lateral ulnar incision was made and it opened directly into a large retro-tendinous collection The sheath was opened and the tendon of the fifth finger was found denuded Pressure on the hand caused more very thick pus to escape The space was drained

June 15th Ulnar deviation of the hand was corrected by a splint to the position of function The drains were removed In the days following it was noted that the fingers remained semiflexed and it was impossible to extend them

June 21st The splint was removed the wounds were nearly healed the wrist and forearm were supple and the fingers semi flexed

End-result The wrist is freely movable The movements of the thumb are normal. The fingers though movable are in flexion contracture from shortening of the muscles because when the wrist and the first phalanges are fully flexed the tendons regain sufficient length to permit extension of the other two phalanges The function of the hand is satisfactory

CASE 53 (*From Dubau summarised*) *Partial phlegmon of the deep central palmar space* (*index compartment*)

P admitted on February 11th 1931 to the Military Hospital of Casablanca with a whitlow of the left index finger which had spread to the interphalangeal joint and which had already been incised three times at his barracks He improved temporarily after vaccination with propidon but on the eighth day the temperature rose to 102° F and he had severe pain.

On examination the finger showed little change but the front of the palm was tense swollen and tender over an elongated area 6 cm in length and 1 5 cm in breadth parallel with the second meta carpal. The thenar and central palmar spaces were normal and painless on pressure The lesion was diagnosed as a phlegmon localised to the index diverticulum

Operation on February 19th Ether anæsthesia and Esmarch bandage Dorsal and palmar incisions exposed the lumbrical, which was greyish in colour. A Kocher's forceps was then introduced alongside the muscle in the direction of the tendons On separating the jaws and applying gentle pressure over the swelling a large quantity of pus escaped Pressure over the central palmar and thenar spaces produced no result The forceps were replaced by fine strips of rubber which were left in place Suppuration ceased in eight days and cure was complete without any residual disability in three weeks

In a third case of localised phlegmon, the palmar suppuration resulted from a tenosynovitis of the middle finger which was treated with success by my incisions

Diffuse Phlegmons of the Deep Central Palmar Space

I have observed only 4 cases

CASE 54 Mrs Ma , aged 45 On February 17th, 1929, she had cut herself slightly at the base of the left middle finger. The small wound became infected and was opened two days later " with a pin which had been carefully sterilised in a flame "

On February 21st she presented all the signs of tendon sheath infection, but in spite of that she was treated medically for a further five days

When I saw the case on February 26th there was obvious tenosynovitis with maximum pain over the superior cul-de-sac Under general anæsthesia the sheath was incised in its lateral aspect, but by the following day the median swelling, with redness, pain on pressure and dorsal œdema, caused us to suspect the presence of a deep cellular space infection

On February 28th the end of the middle finger suddenly became gangrenous and the palm seemed to be full of pus

Under general anæsthesia the middle finger was amputated with resection of the head of its metacarpal, which allowed a certain amount of pus to escape The arteries were patent and bled freely, showing that the thrombosis had not been due, as we had anticipated, to injury of the vessels during the initial operation

The fever and pain subsided rapidly, but paralysis of the interosseous muscles developed When at the end of six weeks the lesions were completely cicatrised, the fingers were in the characteristic attitude (first phalanx in extension, the others semiflexed) and very stiff.

After two months of treatment the improvement was insignificant, but *a year later*, when I saw the patient for the last time, the

hand had fully regained its suppleness and the fingers their movements

CASE 55 Mar (André) aged 25

Phlegmon of the middle palmar space following tenosynovitis of the fourth finger

A wound of the finger tip sustained on December 2nd, 1929 had been regularised and stitched in the casualty department.

He was admitted on the 10th with a typical phlegmon of the middle palmar space Redness of the palm marked out the space

At operation on the 11th the finger was incised up to the palm Disarticulation on the 12th

Re-examined on 19th February 1930 Redness persisted with a sinus at the level of the head of the metacarpal which had been left in place The fingers were in the attitude characteristic of paralysis of the interossei (first phalanx extended the second and third flexed) The flexion was slight about 25 degrees The joints were swollen and painful and the skin thin and shining while the functional incapacity was considerable in degree

PHLEGMON OF THE SUPERFICIAL PRETENDINOUS CENTRAL PALMAR SPACE

For long a superficial variety of phlegmon of the hand has been described by classical writers as subcutaneous This name is erroneous because the collection is subaponeurotic and not subcutaneous, further this description of it lacks precision since neither the site of the pus nor its lines of spread were defined In 1927 I first recognised whilst operating on a palmar phlegmon with an Esmarch bandage that the pus was not situated behind the tendons as Kanavel and Picqué had affirmed but was in fact pretendinous I then believed that this was an error in observation on my part but in 1930 a whole series of operations showed that this variety constituted one of the most common forms of palmar cellulitis and enabled us to study its exact site and propagations The observations that my friend Évrard and myself then made in the department of anatomy of Professor Hovelacque were reported in a series of publications and are summarised in this book. *The pretendinous central palmar space is as clearly individualised and defined as the deep space and during the year 1930 we were able to collect 9 cases of localised infection of this type*

The ætiology is often obscure infected blisters were responsible in 2 cases in 2 other cases the cause was a whitlow

Operation on February 19th Ether anæsthesia and Esmarch bandage. Dorsal and palmar incisions exposed the lumbrical, which was greyish in colour A Kocher's forceps was then introduced alongside the muscle in the direction of the tendons On separating the jaws and applying gentle pressure over the swelling a large quantity of pus escaped. Pressure over the central palmar and thenar spaces produced no result The forceps were replaced by fine strips of rubber which were left in place Suppuration ceased in eight days and cure was complete without any residual disability in three weeks

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itself altered in appearance to a yellow or green colour and lacking its polished aspect is also frequently perforated *The pus is small in quantity*, a few cubic centimetres only

The lines of spread are quite characteristic towards the *skin* of the palm to form a purulent blister with an underlying collar stud abscess We have observed this on three occasions Spread towards the *web* was seen in only one case in spite of the fact that, in experimental injections spread along the lumbricals occurs regularly In the case shown in Fig 79 there was no spread to the commissures but in Case 58 the webs on either side of the middle finger were involved Infection spread to the *thenar space* in *6 cases* although it is impossible experimentally to cause the fluid to spread from one to the other The only possible constant communication would seem to be furnished by the *main muscular branch of the median nerve* which is given off in the central space and which ends in the thenar space The superficial palmar branch of the radial artery which is inconstant in its distribution might possibly also serve as the line of communication (Cadenat) (8) It is of interest to note that this extension of infection to the thenar space may appear secondarily it was in fact present in only two of our cases at the time of the initial operation. In the other four it developed two four five and nineteen days later

Finally the last and very important extension is that into the *forearm* we have seen this in 3 cases As the collection was subaponeurotic in the hand and forearm and wholly *in front* of the flexor retinaculum at the wrist it was difficult to understand how it passed from one to the other The explanation was furnished by plaster injections which demonstrated *its passage alongside the ulnar artery*

These extensions are of frequent occurrence since they were observed *in all but one of our cases* in one case the two most characteristic extensions thenar and antibrachial were already present when we first saw the patient in the others they developed secondarily

Fig 80 illustrates what we have written on the situation of pus and its extension

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The aetiolo the suppuration had persisted for two months

responsible in 2 ral scar and sinus and two other sinuses which had

of the terminal phalanx of the fifth finger, which was later disarticulated on account of tenosynovitis in a sheath that fortunately had no communication with the ulnar



Fig. 79. Phlegmon of the superficial central palmar space with extensions into the forearm and thenar space.

Method of opening this variety of infection. The commissural incision was made to see whether extension into that pocket had actually occurred.

bursa. The other five presented no precise ætiology becac- indefinite cuts or pricks. ffered)

The pus always lies under the palmar aponeur. tendons and tendon sheaths are pressed backward was insigni- posterior wall of the infected space. The po'e last time, the

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appeared simultaneously one in the web of the thumb, the other in front of the wrist

In view of the superficial site of the pus, there is no danger



Fig 80 (*a*) Late result of an untreated phlegmon of the superficial central palmar space which had discharged spontaneously

Three sinuses are seen, one in the palmar hollow, another in front of the wrist, and the third in the web of the thumb Paralysis of the interossei of the last two fingers shows that extension had taken place into the deep space also

of paralysis of the interosseous muscles Correctly incised, these phlegmons heal simply and without sequelæ, their only possible complication being rupture into one of the carpal sheaths

Clinical Features

Pain is very severe and prevents sleep and it is associated with a high temperature *On inspection* the central swelling of the palm is noted with well marked lateral limitations The webs are not generally involved but there is swelling of the front of the wrist with redness and œdema which spread up the forearm Active movements of the fingers and wrist are restricted but passive movements are normal The diagnosis is furnished by careful palpation the centre of the palm and the front of the lower forearm are painful and swollen while the commissures and the hypothenar and thenar regions remain normal (unless of course they should be secondarily involved)

Progress after timely operation is favourable when however the abscess is incised either too late or in an unsatisfactory manner it may spread to involve either the carpal sheaths or the deep central palmar space

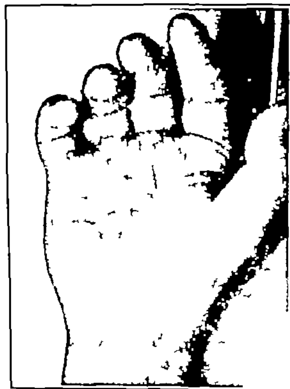


Fig 80 (b) Phlegmon of the superficial central palmar space.

Typical aspect with swelling of the hand and flexion of the fingers, especially on the ulnar side the outer fingers being less affected

In two of our cases the exact situation of the pus was not apparent but it must be added that both were unusual and secondary to synovitis localised to the sheath of the little finger

CASE 56 Fol Charles aged 43 Phlegmon of the central superficial palmar cellular space

Injured on February 21st 1929 by crushing of the tip of the fifth finger He was treated at out patients where the wound was immediately sutured

On February 28th he was admitted to Saint-Louis Hospital with a large phlegmon of the hand The fingers were semiflexed, except the fifth which was half amputated There was swelling, with pain on pressure over the palmar course of the sheath, redness and median swelling above the wrist, but no collection of fluid was perceptible

Operation Under general anæsthesia with ethyl chloride the little finger was disarticulated at its base In conformity with Lecène's opinions, the head of the fifth metacarpal was left An incision in the line of the sheath showed that the pus lay alongside it, in the adjacent cellular space A second incision was made in the forearm along the ulna, exposing the posterior aspect of the sheath, which was œdematous The sheath was incised and the tendon found to be normal in appearance with no intrasynovial pus

March 5th As the temperature failed to subside completely a fluctuating collection in front of the wrist was opened by a median incision and it was found that this collection communicated with that on the palm

March 12th The temperature kept round 100° F and a collection of pus was found in the thenar space A commissural incision evacuated a considerable accumulation of pus Exploration with the finger showed that this was superficial, just below the skin, and apparently in front of the tendon

March 17th The temperature then subsided and remained with small oscillations round 98 6° F The persistent œdema of the fingers and hand suggested that there might be arthritis of the wrist, in which there was creaking on gentle passive movement Plaster was applied and immobilisation maintained until the end of June

Re-examination January, 1930 The wrist was found to be ankylosed in slight dorsal flexion Movement at the inferior radio-ulnar articulation was restricted to half the normal range Extension of the three fingers was normal but they could not be flexed to touch the palm There was no deformity and no trophic troubles The thumb movements were slightly impeded by contraction of the scar

Prognosis

The prognosis is good on the whole Apart from the case detailed above and two others in which stiffness of the finger persisted, the remainder healed in about three weeks without any sequelæ, but this was due to the fact that all secondary extensions of pus were promptly recognised and treated as soon as they became manifest

Diagnosis

The final diagnosis rests on the central localisation of the signs of inflammation with spread to the forearm as verified by pain elicited on gentle palpation

It is easy to distinguish the superficial phlegmon from a thenar hypothenar or commissural infection none of which involves the central portion of the palm Once I made an erroneous diagnosis of ulnar tenosynovitis in a case (Case 56), in which the terminal phalanx had been amputated and the digital sheath definitely infected The hook sign was useless as the terminal phalanx was absent the shooting pain and the presence of a collection in front of the wrist (which is according to Kanavel characteristic of a burst synovial infection—an observation I have been able to verify once) simulated a tenosynovitis By a latero-ulnar incision, I opened the sheath which did not contain any pus and the exact localisation of the infection was only recognised later

It may be impossible to make an accurate differential diagnosis on clinical examination An Esmarch bandage should be applied the collection opened where it points and the pouch explored Pressure is then applied to the forearm and if pus exudes it must come from a deep collection, *i e* a synovial infection which will require appropriate treatment (*v* p 234 Case 52)

Treatment

Treatment consists essentially in opening the collection and any extensions preferably at one sitting but if need be by two or three operations Under general anæsthesia and after a hæmostatic bandage has been applied, the palm is incised in the mid line There is no danger of wounding either vessel or nerve which lie deep to the pus The collection is opened and its situation determined The edges of the skin and aponeurotic wound should then be *excised* to prevent their tendency to close A curved forceps is inserted to explore towards the thenar space and towards the forearm Any spread in either direction is treated by a counter incision placed as required in the thenar commissure or in the forearm and two drains are passed through the three openings (Fig 79) If however the forearm spread does not extend far above the wrist it may be sufficient to drain it by an upward extension of the median palmar incision

Immediate Results

Three patients were cured by a single operation In one, there was no extension; in the second, extension in both directions was present, and the third had thenar involvement only In the other cases, two operations were required because the extension manifested itself secondarily, two, three, four, five and even nineteen days after the primary intervention.

End-results

As a rule, rapid healing took place as soon as all the extension tracks had been laid open 5 cases were healed in from two to four weeks after the primary operation, with no sequelæ, in 2, there was some stiffness of the index and ring fingers respectively Lastly, in 2 the result was bad because of the complexity of the lesions associated with the phlegmon of the superficial central palmar space (case 56)

Illustrative Cases

The first case is an example of superficial phlegmon with early extension to the forearm and commissures, and with secondary involvement of the thenar space (9).

CASE 57 Hai (Edmond), aged 53 (November 7th, 1930)
Phlegmon of the superficial central palmar space with two early extensions

The patient had pricked himself about October 25th and again on the 30th of the same month

There was a large purulent blister, measuring about 2 cm in diameter, on the upper part of the palm The skin was reddened, especially towards the wrist There was little induration of the palm

Operation in two stages was indicated *First operation* on October 30th Simple excision of the purulent bleb *Progress* was at first satisfactory but the patient returned on November 7th The fingers were found to be in a semiflexed position but extension was possible though painful in the third and fourth fingers The whole palm was red and swollen and both it and the fingers were painful on pressure

November 7th *Operation under general anæsthesia* with ethyl chloride Pus was found in the expected sites with two extensions, one thenar and the other towards the wrist

Counter-incision and drainage of the thenar space extension

Counter incision and drainage with rubber strip of the extension towards the wrist

November 11th Suppuration having ceased the drains were removed

CASE 58 Jou (Albert) *Phlegmon of the superficial central palmar space with secondary involvement of the commissure*

Admitted to hospital on June 15th Phlegmon following injury to the palm by fragments of an electric light bulb For five days there had been pain swelling and sleeplessness

Examination The hand was mobile and all the fingers functioned perfectly

Operation June 15th (Kauffmann) An incision along the inner border of the thenar eminence was prolonged towards the base of the fingers

June 17th Dorsal counter incisions were made in the third and fourth commissures

June 20th Small collar-stud abscess

The patient left hospital on June 28th

Re-examined on July 25th Some flexion contracture of the third finger persisted but gradually cleared up later

CASE 59 Mme Gob (Mathilde) aged 41 wife of a petty officer *Phlegmon of the central superficial palmar space with secondary extension to the forearm*

She had sustained a punctured wound with iron wire on July 11th at Rouen

July 16th Great swelling into which a small incision was made

July 21st Referred to Saint-Louis Hospital.

Examination Swelling of the central and upper portion of the palm (*le talon de la main*) with redness in front of the wrist and of the thenar eminence

The commissures were not involved. The back of the hand was swollen and the function of the fingers was normal

July 23rd G.A. A direct incision opened up a subaponeurotic cavity distended with pus The incision was enlarged to permit of exploration with a finger The tendons lay behind. Exploration of the spaces Incision and counter incision of the commissure was negative Incision and exploration of the hypothenar space was also negative The thenar space was distended with pus which welled up from the median wound when pressure was applied An incision was made into the commissure of the thumb and a through and through drain inserted. Propidon.

July 26th Reintervention under G.A. The transthenar drain which had fallen out was re-introduced. The anterior aspect of the wrist was incised and drained (v Fig 79)

July 28th The drains were removed
Progress was satisfactory and the temperature subsided
Discharged on August 7th

A Folliason (10) of Grenoble made the following comments when he described an absolutely typical case to the *Société anatomique* in 1932

"The individuality of this comparatively rare variety of phlegmon has only been recently recognised The classical descriptions distinguished only two varieties of suppuration one subcutaneous and the other retro-tendinous (Picqué—Kanavel) The recent work of Marc Iselin has drawn attention to this particular variety of phlegmon of the superficial central pre-tendinous palmar space

"We have verified in every particular in our case the exactitude of the descriptions of that author"

COMMISSURAL PHLEGMON

The commissural phlegmon is localised in the small space already described on p 222, and it is the most common of all phlegmons, as we collected 13 *cases* in 1930 Its individuality is recognised neither in classical writings where it is confounded with a suppurating callosity[1] nor by Kanavel, who regards it as the *lumbrical spread*, of a pointing deep cellulitis On the other hand, Klapp and Beck give a very accurate description of it, which confirms my observations, a confirmation which is particularly valuable where my own opinion differs from that of Kanavel with regard to the direction of the extensions of infections commencing in the web.

Ætiology

Infection of the commissure must not be confused with suppuration under a callosity, because the one is not always the cause of the other Thus in 1930 we operated on 5 cases of suppuration under callosities without propagation to the

[1] The suppurating corn or callosity consists of an accumulation of serum, then of pus, under a callosity The usual spread is towards the commissural space exceptionally into the thenar space The pain is not severe and the general signs are slight Spontaneous opening to the exterior is usual if it is not incised At operation, the epidermal covering, which constitutes the callosity, should be excised and any spread into the web should also be drained

commissure, and of our total of 13 cases of commissural infection 5 only were so caused while the other 8 were caused by other lesions such as punctured or incised wounds

Site of the Pus

The pus lies in the tiny commissural space which is described on p 222 and which is about the size of a cherry stone when well defined

Propagation Experimental injections have taught us that

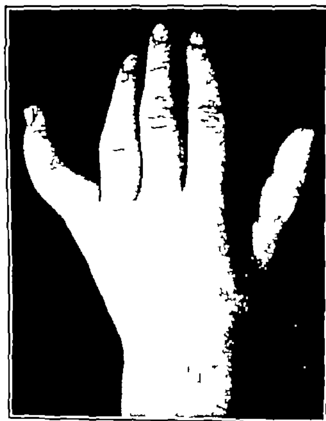


Fig 81 Phlegmon of the commissural space Typical appearance with separation of the little finger and swelling of its base

the pus never spreads towards the deep palmar space The direction of spread is backwards to the dorsum of the commissure and thence towards the back of the hand *The most characteristic direction however is lateral* the infection passing from one web to another without spreading in depth Figs 84 and 85 represent typical examples of this It has however proved impossible to reproduce this propagation

July 28th The drains were removed
Progress was satisfactory and the temperature subsided
Discharged on August 7th

A Folliason (10) of Grenoble made the following comments when he described an absolutely typical case to the *Société anatomique* in 1932

"The individuality of this comparatively rare variety of phlegmon has only been recently recognised The classical descriptions distinguished only two varieties of suppuration one subcutaneous and the other retro-tendinous (Picqué—Kanavel). The recent work of Marc Iselin has drawn attention to this particular variety of phlegmon of the superficial central pre-tendinous palmar space

"We have verified in every particular in our case the exactitude of the descriptions of that author"

COMMISSURAL PHLEGMON

The commissural phlegmon is localised in the small space already described on p 222, and it is the most common of all phlegmons, as we collected 13 *cases* in 1930 Its individuality is recognised neither in classical writings where it is confounded with a suppurating callosity[1] nor by Kanavel, who regards it as the *lumbrical spread*, of a pointing deep cellulitis On the other hand, Klapp and Beck give a very accurate description of it, which confirms my observations, a confirmation which is particularly valuable where my own opinion differs from that of Kanavel with regard to the direction of the extensions of infections commencing in the web

Ætiology

Infection of the commissure must not be confused with suppuration under a callosity, because the one is not always the cause of the other Thus in 1930 we operated on 5 cases of suppuration under callosities without propagation to the

[1] The suppurating corn or callosity consists of an accumulation of serum, then of pus, under a callosity The usual spread is towards the commissural space exceptionally into the thenar space The pain is not severe and the general signs are slight Spontaneous opening to the exterior is usual if it is not incised At operation, the epidermal covering, which constitutes the callosity, should be excised and any spread into the web should also be drained

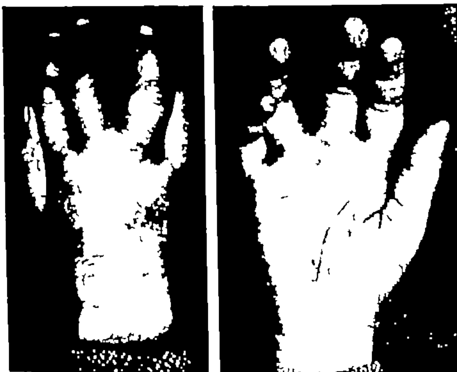


Fig 82 Phlegmon of the third commissure Absolutely typical appearance with marked swelling of the other commissures, whilst the palm is flat and quite unaffected The infected commissure is marked by separation of the corresponding fingers



Fig 83 Method of opening the lesion by two incisions and transfixion strip

experimentally, although it is recognised by Klapp and Beck and it undoubtedly occurs clinically. The pus may thus invade the three web spaces (*v* case 62)

Clinical Features

The pain localised to a web is very severe but fever is slight In from two to four days the collection has taken place and the clinical signs are obvious The two fingers on either side of the affected commissure are separated and cannot be approximated The web is red and swollen both in front and behind The swelling is *symmetrical*, affecting the adjoining bases of the fingers to the same extent, a feature which is characteristic and which distinguishes it from a whitlow of the first phalanx involving the commissures, for in the latter the swelling is more marked on one side and is essentially *asymmetrical* (*cf* p 166).

The affected region is extremely painful to localised pressure, especially on the palmar aspect The other commissures are often swollen, red and painful, but the tumefaction so caused is confined to the base of the fingers, while *the hollow of the palm and its surroundings remain absolutely normal* (*v* Figs 82 and 84) Lastly, finger movements, though restricted, are still possible and painless

Evolution. We have never seen propagation of the infection in depth along the lumbricals The pus, on the contrary, tends to spread towards the dorsal aspect and into the neighbouring commissures (*v* Figs 81 and 84) One only of our cases was serious and ended with sloughing of the tendons of the index at the level of the suppurating focus This tendon involvement was only recognised when the collection, which had been fully opened, failed to heal The finger in that case was amputated with the head of its metacarpal bone All the other cases healed up without incident in from eight to fifteen days

Diagnosis

The final diagnosis depends on the presence of swelling in the region of the webs, one of which is chiefly affected with separation of the corresponding fingers, and on the well-localised pain

The symmetrical distribution of the swelling rules out a *whitlow of the first phalanx* (this differential diagnosis is important for therapeutic reasons) *Other varieties of phlegmon of the hand* are excluded, because their regions remain intact

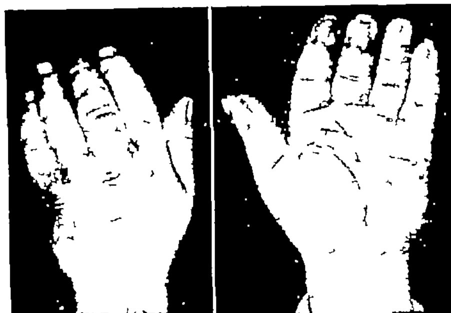


Fig 84 Commissural phlegmon with involvement of all the commissural spaces

Fig 85 The same operated on by six incisions and three transfixion strips

Lastly, *digital tenosynovitis* with lateral extensions can be excluded because, in the latter, the pain is median and most marked in front of the metacarpo-phalangeal joint, in contrast with the commissural infection in which the pain is definitely interdigital

Treatment

The methods of treatment may be medical by injection of the bacteriophage-antivirus mixture of Rosenthal, or surgical by incision

The former is easy and harmless, provided that the elementary precaution is taken to perform the injection by the dorsal aspect and not to puncture directly the palmar surface. My pupil, Dumas, has thereby achieved some interesting but inconstant successes The last cases on which we operated had received this preliminary treatment, and that may be why they progressed so favourably From the dorsum, two injections of a few drops of antipyogenic bacteriophage-antivirus mixture is made into the actual site of infection If healing does not speedily ensue (for any beneficial action should be observed soon), operation should be proceeded with

Under General Anæsthesia and with a Hæmostatic Bandage An incision 2 cm in length is made on the palmar aspect to evacuate the collection A dorsal counter-incision is added and a strip of rubber pulled through In all our cases but one, this technique sufficed In case 62 it was necessary to open the other two commissures on the following day I would, in a similar case in future, simply split the whole web from front to back I did this unnecessarily in my last case, since the infection was localised to the small palmar pocket and had spread neither towards the commissure nor towards the dorsal aspect This splitting of the web leads to no inconvenience later on, and it should be preferred to a through and through incision, whenever the infection appears to be serious (Cadenat)

The three cases cited below represent the three anatomo-clinical types of commissural phlegmon In the first, the infection was localised to that small commissural pocket which we have been able to define by experimental injection In the second, it had spread (probably along the lymphatics) towards the dorsal portion of the commissure While in the third, the phlegmon had diffused from the commissure primarily affected to the other two

August 23rd Dorsal and palmar counter incisions with a transfixion drain

Suppuration persisted till the end of October Healing was complete on November 14th with some stiffness of the middle finger Flexion of the other two was satisfactory

DORSAL PHLEGMON

According to the classical teaching there is no pus in the dorsal swelling of an infected hand the infection is in the palm and it is considered bad treatment to incise the back of the hand Such a dogmatic opinion is untenable because a more or less extensive purulent dorsal collection may complicate a palmar tenosynovitis (11) or a commissural phlegmon (case 61) Further we have observed *two cases in which the phlegmon was wholly restricted to the dorsum with no infection of the palmar spaces* Lastly Pellé (12) (of Rennes) has shown at the *Société de Chirurgie* cases that developed *palmar extensions of pus from primary dorsal phlegmons*—a disposition absolutely inverse to what is generally admitted The signs and the treatment are the same for both varieties We have selected an idiopathic one for description as typical of the condition



Fig 80 Method of opening a phlegmon of the dorsal space by short incisions connected by drainage strips. The end result was perfect

Ætiology In our 2 cases the phlegmon originated from infection of the dorsal aspect of the first phalanx of the index in one, and of the middle finger in the other The lesion in the

CASE 60 Mlle Mer *Commissural phlegmon of the third space.*

Precise ætiology was lacking, possibly due to a prick Bacteriophage-antivirus had been tried without effect

April 10th · Very severe pain The fourth and fifth fingers were separated, the commissure swollen and red especially on the palmar side Dorsal œdema and redness which involved the bases of the fourth and fifth fingers

G A The whole commissure was opened up to enable the limits of the collection to be studied It proved to be about the size of a hazel nut and was well localised to the palmar side, where it occupied the small space. *There was no spread towards the dorsum* The collection was drained. Cure in ten days. As the wound cicatrised the fingers gradually approximated The end-result was perfect.

CASE 61 Par . . . (Jules), aged 22 *Phlegmon of the commissural space with spread towards the dorsal side*

The patient had pricked himself with a fork about August 2nd, 1931 He attended Saint-Louis Hospital on August 9th. The appearance was typical of a commissural phlegmon of the third space with separation of the fourth and fifth fingers and particularly well-marked dorsal swelling

August 10th : Under general anæsthesia the whole width of the web was split open by an antero-posterior incision The purulent focus occupied the whole space Surface dressing without drainage. Complete healing in ten days

CASE 62 Las (Antoine), aged 37 *Phlegmon of the three commissural spaces*

Injured on June 18th Commissural phlegmon which predominated over the interval between the third and fourth fingers The fingers flexed normally The palm was supple, the dorsum swollen

June 22nd G A Through and through incision in the third space

June 28th G A The infection had spread to the other commissures which were incised in like manner. The swelling and pains diminished, but the back of the hand remained swollen Propidon caused the signs to disappear The suppuration became chronic Some sloughing at the index finger followed by sinus formation indicated an involvement of the deep tendons

July 19th Counter-incision and drainage near the sinus

July 29th Exploration under G A showed that the tendon was completely necrosed

August 7th Disarticulation with resection of the head of the metacarpal The infection persisted, however, and extended towards both the dorsal and palmar aspects

be masked by the extensive œdema of the back of the hand If the palm is primarily affected and if after it has been opened the temperature rises again it is safe to conclude that pus is also present on the dorsum If, on the contrary the localisation is restricted to the dorsum redness and fluctuation there indicate a fluid collection

Treatment Under general anæsthesia but without an Esmarch bandage which is unnecessary the base of the inter digital space in which pus is suspected to be present is incised first If pus escapes the limits of the pouch are explored with the points of a curved forceps and two or three counter incisions are made and drains inserted from one to the other (v Fig 86) It might be urged that one long incision would drain the pus more effectively, but the lateral recesses would not thereby be drained and a long wound heals more slowly and is apt to leave a troublesome scar Further the advantages of multiple short incisions in draining superficial collections have been generally recognised since this method was introduced by Chassaignac

CASE 63 Jul (René) *Phlegmon of the dorsal space*

On June 24th 1930 this child burnt himself on the back of the first phalanx of the index. The wound became infected and from the second day there was great swelling of the back of the hand

June 29th The patient suffered and had no sleep for two nights Temperature 103 F The hand was swollen to twice its normal size with great deformation of the dorsal aspect The œdema involved the bases of the fingers and had spread to the forearm The inflammation was limited above by the wrist The palm was normal. Fluctuation was present over the dorsum and was especially marked towards the commissures

General anæsthesia with ethyl chloride Incision where fluctuation was best marked Pus escaped in quantity Forceps were passed in to the limit of the collection along the line of the fifth metacarpal

July 3rd The signs of inflammation persisted from extension towards the radial border Counter incision drain Progress Healing took place without incident and was complete by August 2nd without leaving any incapacity

CASE 64 Vat (Jeanne) aged 20 *Dorsal phlegmon following incision of a carbuncle*

September 14th Carbuncle of the back of the first phalanx of the left middle finger which was opened by a crucial incision

September 16th Swelling of the whole dorsum of the hand Pain fever general malaise Fomentations

former was an infected electricity burn, in the latter, it was a carbuncle that had been incised

Site of the Pus. The pus is *subcutaneous*; the vessels, nerves and tendons are displaced forwards against the deeper planes I have never seen infection under the tendons, *i e* in the subaponeurotic space described by Kanavel

Propagations. The pus spreads over the whole extent of the dorsal aspect, but remains confined to the hand and does not extend to the wrist It does not involve the sheaths of the dorsal tendons In exceptional cases, however, it may spread along the commissures towards the palmar aspect



Fig 87 End-result of dorsal phlegmon (*cf* Fig 86)

Clinical Features. The pain is moderate, but the temperature rises rapidly Inspection reveals considerable swelling with redness of the entire dorsum of the hand The œdema involves the roots of the fingers and spreads upwards to the forearm, which is streaked by lines of inflamed lymphatics The roots of the fingers are markedly tender on palpation, and fluctuation is more or less obvious

Evolution. The course of all our cases has been long, and in this respect this localisation of infection is more serious than the commissural or superficial middle palmar infections just described The period of treatment varies from two to six weeks, but this infection does not, in my experience, leave any sequelæ, apart from some stiffness, which clears up rapidly

Diagnosis. Diagnosis is not always easy because pus may

CHAPTER XVI

PHLEGMON OF THE SYNOVIAL SHEATHS OF THE HAND

(Tenosynovitis of the Radial and Ulnar Bursæ)

We have shown in the preceding chapter how the question of phlegmons of the hand gradually evolved Due credit must be given to Gosselin and Ed Schwartz for establishing the important anatomical and clinical facts concerning infection of the synovial sheaths of the hand

Anatomy

The sheaths enclose the flexor tendons in the carpal canal and in the palm they are always two in number—the radial and the ulnar (Fig 88)

The *radial sheath or bursa* surrounds the long flexor tendon

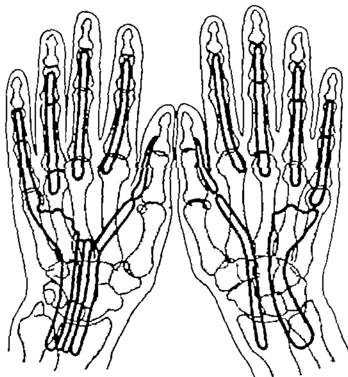


Fig 88 The synovial sheaths of the flexor tendons. The more frequent type is shown on the left (after Kanavel)

September 18th Obvious fluctuation Incision along the dorsum of the two-three commissure obtained pus The limits of the pouch were explored with forceps and two counter-incisions made, one over the fourth metacarpal and the other 3 cm below the wrist. Rubber strips were passed between the incisions.

Healing gradually took place in just over six weeks

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12 A PELLE "Oedeme du dos de la main dans le panaris de la face dorsale" (Rapport de P Moure) (*Bull Mém Soc Nat Chir*, No 61, pp 329–331, 1935)

Pathological Anatomy

It is easy to determine the *site of the pus* in the cases in which diffusion has not yet taken place It completely fills the radial bursa but in the ulnar bursa it only occupies the deeper retro-tendinous portion, where the communication with the digital sheath of the little finger is situated The whole extent of the bursa is not necessarily involved and the *tenosynovitis may be localised* to the digital portion of the tendon sheath when that portion is partitioned off I have myself seen 4 such cases 2 of radial and 2 of ulnar bursa their prognosis is naturally better

CASE 65 Mrs R *Pulpar whitlow of the right thumb with operative infection of a partitioned sheath*

Injured on October 20th Incision by her own doctor and re-incised two days later Admitted to the Saint-Louis Hospital on October 28th with all the signs of commissural phlegmon. An oblique incision 4 cm long was made into the thenar eminence parallel with the tendon On October 31st there was great swelling of the thenar space with a dorsal extension from which pus exuded on pressure Under general anaesthesia a dorsal thenar counter incision was made and a transfixion drain inserted The sloughing tissue was excised and the bared tendon was seen in the depth of the wound Gauze dressing On November 8th the interphalangeal articulation was excised. Despite free drainage the thumb remained œdematous and stiff It was put up in plaster in position of function On December 5th when the plaster was removed there was slight suppuration. Re-examined on January 14th 1931 the finger was contracted in flexion The redness of the skin persisted with a small sinus over the metacarpo-phalangeal joint which was freely movable The terminal phalanx could not be flexed as the tendon had sloughed

CASE 66 Mrs V *Whitlow of the right thumb complicated by localised phlegmon of a partitioned sheath and extension into the thenar space*

Punctured wound on July 25th 1930 incised on the 26th Admitted to Saint-Louis Hospital on August 2nd. The infection of the thenar space was treated by incision of the commissure and counter incisions On September 23rd (a month later) bilateral sinuses persisted. Under general anaesthesia a track was followed into the palm and treated by incision and counter incision and the necrosed portion of the terminal phalanx was removed The joint seemed to be intact An extension to the dorsum from the bony focus was opened by lateral incisions which did not open the joint Transverse dorsal drain. The localised phlegmon of the

of the thumb and becomes continuous with the digital sheath at the base of the thumb The *ulnar bursa* furnishes a sheath for the two layers of the flexors of the fingers In a transverse section (*v* Fig 70, p 214) it presents three *culs-de-sac*, which lie in front of, between and behind the tendons The last is the largest and communicates with the digital sheath of the little finger

The two bursæ extend, therefore, from the inferior part of the forearm to the terminal phalanx of the thumb and of the little finger They may communicate either directly or through a small additional sheath connected with the index tendon It is very important to determine the upper limit of the proximal *cul-de-sac* because, as we shall see later, that situation is the site of election for opening and draining the sheath by recent methods.

X Gellé, at my request, has made injections to determine the upper level of the sheath in twenty hands "*The extent of its upward spread is variable* It may extend a distance of 15 millimetres above the joint line As, however, the latter is oblique this corresponds to a point about 25 millimetres above the radial styloid process, which can be determined with precision *In another specimen the* cul-de-sac *did not extend upwards beyond the upper border of the scaphoid* and did not reach the level of the radiocarpal articulation Between these two extremes we have found that it reached various intermediary levels" (X Gellé).

Frequency

The condition is relatively infrequent In 1930 we only observed 2 cases, while in the same year I treated 28 cases of phlegmon of the cellular spaces, and it took my friend Leibovici and myself nearly two and a half years to collect the 6 cases that we treated by interrupted and lateral incisions, and that we published in the *Journal de Chirurgie* in March, 1931 (1) It is probable that this decrease of frequency is due to improved methods of early treatment of small wounds, and perhaps to the application of tincture of iodine, which has everywhere become a ritual since the war of 1914-18

The Ætiology

Is generally a punctured or incised wound in the neighbourhood of the tendon, which infects the sheath Less often the infection is due to an extension of a subcutaneous whitlow of the first or fifth finger, or of a phlegmon of the cellular spaces

than the staphylococcus We have been able to verify this observation. This danger is especially liable to occur from re infection by the dressings during the post-operative treatment *The age* of the patient is of essential importance We have observed cases of phlegmons of the sheaths that were not operated on till the tenth day and that recovered completely, but these occurred in young subjects On the

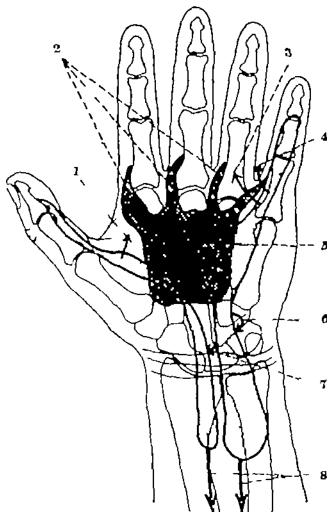


Fig 89 Diagram of the principal purulent tracts that may complicate phlegmons of the synovial bursæ

1 Extension into the thenar space 2 Lumbrical extensions from the central palmar space. 3 Spread into the sheath of the ring finger 4 Lumbrical tract towards the inter-digital commissure and back of the hand. 5 Extensions into the central palmar space 6 Extensions into the radio carpal articulation. 7 Spread from one bursa into the other 8 Extensions into the forearm.

other hand patients aged 50 or over who were operated on very early all developed sloughing of the tendons despite every possible care These facts are confirmed by the statistics given by Forsell and Klapp

The Propagations The lines of spread of the infection beyond the sheath merit attentive study for they constitute serious cases in which healing can only be achieved when one knows where to find the pus and how best to evacuate it Fig 89

radial sheath cleared up two months later after elimination of the flexor pollicis longus tendon

The character of the exudate varies with the time of intervention, and we have been able to follow the process in its various stages *In a very early case* a moderate quantity of clear fluid escaped suddenly when a subcutaneous whitlow of the base of the thumb was explored In spite of our fears, the infection did not progress *At a later stage* the sheath is not entirely filled with pus Case 6 in the paper I wrote with Leibovici was a characteristic example the superior *cul-de-sac* only contained turbid fluid (which yielded staphylococci on culture), while there was true pus in the palmar portion The suppuration, therefore, is not diffuse in the early stage *When the condition is fully developed*, the sheath is entirely filled with pus (*cf* Cases 1, 2, 3, 4 and 5 in the article already referred to). *At a still later stage* the pus bursts the sheath and invades the cellular spaces *The prognosis and operative difficulties then change completely*

Bacteriological examination usually reveals the association of streptococci and staphylococci Nevertheless, *gonococcal tenosynovitis* may occur, and was found in two of our cases

The state of the sheath is exactly similar to that described in digital tenosynovitis Its external aspect is œdematous and is encircled by dilated blood vessels, the interior is dull, thickened and, in places, shows dark yellow plaques

The tendons in this situation appear to offer more resistance to the infection than in the fingers, and preserve longer their polished aspect Nevertheless, they finally turn yellow and lose their brilliance, they soften and shrink as their vascular synovial folds, the *vincula tendinum*, become destroyed by the suppuration They rarely slough except in the thumb In the ulnar bursa the tendons tend rather to adhere together into a large fibrous bundle, which also becomes adherent to the walls of the sheath

It is important to determine the exact cause of tendon sloughing It is difficult to find this out with certainty, but a certain number of facts are indisputable The resistance of the tendon depends primarily on its *anatomical situation ;* the ill-nourished digital portions are fragile, while the carpal portions are much more resistant *The causal organism is a further factor* S Koch and Schneck have emphasised the surprising fact that the tendon resists the streptococcus better

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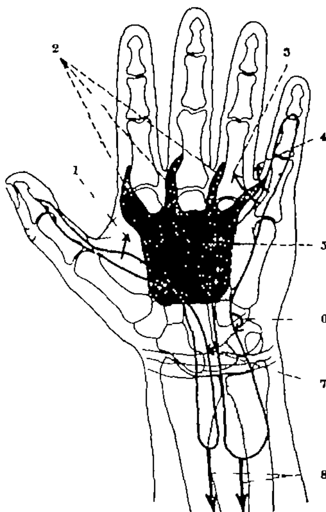


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direction the two sheaths were involved the thenar and middle palmar spaces the back of the hand and finally the forearm In spite of that the final result was excellent, as one may appreciate from Fig 102

Spread to *the wrist joint* is a very serious complication The prognosis as to function is very bad indeed and the patient s life may be endangered This infection was believed by older writers to pass directly from the bursæ to the articulation alongside the hamate bone (E Schwartz) I doubt the truth of this view which is based on studies on the cadaver because in the 2 cases of arthritis of the wrist that I was able to investigate, lateral incisions had been made and had opened up widely the retro tendinous space which was found free from pus Pus was however, present in the cellular spaces of the hand and particularly *in the commissures* Then again I have observed 3 cases of arthritis of the wrist one of which was serious and had resulted from a small infected wound of the base of a finger P Moulonguet has also observed a serious case that was caused in a similar manner and in which resection of the wrist became necessary It is difficult to find a satisfactory explanation for this arthritis which may possibly take place through the lymphatics though no definite proof for this theory is at present available

Arthritis of the wrist is by no means infrequent It occurred in 2 of the 40 cases that I collected in 1027 in 3 of the 7 cases observed during the year 1930 and in 1 of my 5 personal cases

The gravity of the infection varies considerably (*a*) *Reactionary Arthritis* Subacute without pus formation and without any bony lesions the cartilage loses its normal polished appearance the ligaments are lax and progressive ankylosis ensues (*b*) *Suppurative Arthritis* The articulation becomes full of pus with lesions of osteitis which necessitate resection or amputation. I have had only 1 case of this kind (Case 8 p 3)

Modern technique has happily diminished the frequency of this redoubtable complication which I personally have observed only once

Anatomical Evolution

When the phlegmon is operated on early cure may take place very simply But even after a well planned intervention extensions of the infection may occur and must be sought out

illustrates diagrammatically the direction of the different lines of spread from the ruptured bursæ

The infection may pass *from one bursa to the other*, generally along the pre-existing anatomical communication, which is fairly common This gives rise to a diffuse phlegmon of the sheaths, which the German writers call the " V phlegmon " or " crossed phlegmon," and of which I have seen only 2 cases

The possibility of spread *from the ulnar bursa to the sheath of the fourth finger* is noted by Kanavel, I have also seen it once The infection probably takes place along the corresponding cellular space

Extensions into the *cellular spaces* are frequent and important It occurred in 3 of our cases. *Involvement of the*

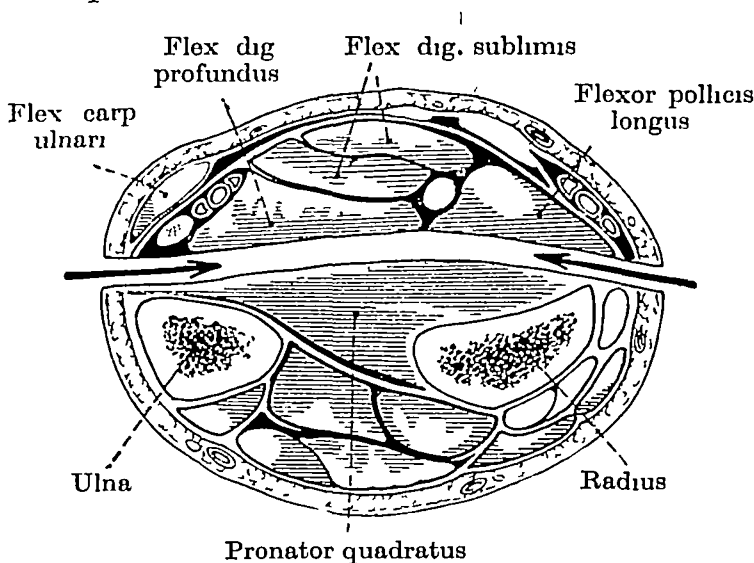


Fig 90 Section of the forearm (after Farabeuf) slightly modified to show how the lateral incisions directly expose the Pronator quadratus muscle, in front of which the pus is found

forearm is most serious The pus escapes from the radial or ulnar bursa and fills the cleavage plane that lies behind the posterior aspect of the sheath and in front of the pronator quadratus This space is known abroad as the " space of Parona " (Fig 90), although its importance had long been emphasised by Chassaignac, Gosselin and Dolbeau. Further spread then takes place upwards into the forearm *along the plane between the two groups of flexor muscles*, and beyond that along the vascular sheaths, although I myself have never seen upward spread to that height

The cellular spaces of the hand were invaded in 5 of my cases mid-palmar pre-tendinous 1, pre- and retro-tendinous 1, retro-tendinous only, 1, commissural 1, thenar 1, and dorsal 2 In another case the infection had spread in *every possible*

Simple Tenosynovitis The classical signs of phlegmon of the sheath are present the hook sign and the shooting pain The hook sign (*signe du crochet*) is portrayed thus the fingers being in semi flexion any attempt by the surgeon to straighten them is immediately arrested by intense pain which is felt most severely in the infected finger Thus in a phlegmon of the radial bursa the thumb only is completely rigid and inextensible while the other fingers can be extended In the phlegmon of the ulnar bursa on the contrary the thumb remains free but the other fingers resist traction in an unequal manner the maximum difficulty being encountered in the little the least in the index finger This sign has wrongly been regarded as an essential characteristic of synovial involvement it was lacking in no less than 3 of my 5 personal cases seen in 1929-1930

As a matter of fact the painful rigid and hooked finger is caused by the distension of the sheath A distension which disappears when the sheath bursts or when it is opened surgically even by a small incision It is obvious therefore that rigidity and flexion of the finger—the hook sign—is no longer found when the tenosynovitis has become diffuse

Diffuse Tenosynovitis The classical signs of tenosynovitis are no longer present The difficulty lies in the recognition of a synovial infection underlying the more evident collections in the cellular spaces

The diagnosis cannot be made with certainty till the patient is anæsthetised because then only is it possible to carry out the examination without inflicting severe pain. The presence of a deep collection in the forearm especially if it is possible to feel fluctuation transmitted between the forearm and hand indicates that diffusion has occurred from a tenosynovitis into Parona s space Kanavel attaches similar importance to the appearance of a little subcutaneous collection in front of the wrist I believe he overlooks thereby a possibility of error because a superficial collection of this kind may well result from spread upwards into the forearm of an infection of the superficial middle palmar space

The granulations that surround any existing wound or incision should be carefully excised with curved scissors and if bared tendon is seen on separating the edges of the wound the existence of synovial involvement can be taken for certain Again if during operation any notable quantity of pus escapes

When the phlegmon is opened late or inadequately, pus spreads in all possible directions to invade the forearm and the wrist joint, and it diffuses throughout the spaces of the hand with complete destruction of function The patient's life may be endangered, even to-day death occasionally occurs as a result of phlegmon of the hand, and when one reads Chassaignac one is horrified by its former frequency Finally, the tendons become fused together, the joints ankylosed, the interossei paralysed and the vessels and nerves compressed in a sclerous mass The disability may be equivalent to loss of the hand We shall see, however, that, thanks to modern methods of treatment, such grave results tend to become exceptional

It is essential to distinguish clearly the two main forms of phlegmons of the bursæ

The purely synovial form, in which the *diagnosis based on the classical signs is easy, the treatment simple and the prognosis excellent with modern technique*,

The diffuse form, in which *diagnosis is difficult, of which the treatment calls for multiple interventions and in which the outlook is much more uncertain*

In the first type, the pus is still within the synovial sheath, the signs are definite and the prognosis is good if early intervention is carried out In the diffuse tenosynovitis, pus has already spread to one or several of the spaces described, the signs are misleading, intervention difficult and often incomplete, and the prognosis correspondingly gloomy

Clinical Features

Onset

Pain appears on the day following infection, first in the finger, then in the hand and wrist It increases rapidly and prevents sleep It is accompanied by a rise of temperature (102° to 104° F) The general appearance of the patient, his pallor and depression bespeak from the start the serious nature of the infection *On inspection*, the hand is enormous, swollen on its palmar but especially on its dorsal aspect The swelling and redness spread to involve the front of the forearm The *fingers* are semi-flexed

Infection Established

The clinical picture differs in simple and in diffuse tenosynovitis

was flexion of the ring finger, and that persisted even after the infection had subsided On occasion a digital tenosynovitis may clear up without direct incision, we have reported several cases (p 207) of this kind, which were simply treated by com missural incisions and through and through drainage the next case was also treated by indirect drainage

CASE 67 (M Iselin) *Phlegmon of the ulnar bursa complicated by infection of the sheath of the ring finger Interrupted lateral incision Cure with excellent functional result*

M. Coq aged 26 was injured at the beginning of June 1930 on the right little finger by the bristle of a metal brush Several days later on April 5th a doctor had made a small incision into a whitlow that had formed on the finger No improvement He was admitted to Saint-Louis Hospital under Professor Mathieu on April 9th with all the signs of an infection of the ulnar bursa rigid hooked finger pain and swelling of the forearm fever and sleeplessness

Operation April 9th 1930 Under general anæsthesia and after application of an Esmarch bandage the palm was incised lateral to the hypothenar eminence and the sheath opened pus escaped. An incision was then made over the ulnar border of the forearm on opening the aponeurosis no pus was discovered in the subjacent cellular tissues but the upper end of the bursa was seen to be distended with pus Pus escaped when this was incised and two small drains were inserted

Post-operative course On the second day secondary hæmorrhage occurred and was at first alarming It ceased, however after the removal of the clots and the application of a fresh dressing On the third day the temperature still kept up and the hand remained swollen. A dorsal counter incision was made to complete the drainage During the following days though the progress of the hand was satisfactory it became necessary to open a deep extension in the forearm which had been insufficiently drained Cure rapidly ensued and the patient was discharged from hospital on April 19th Finger movements were satisfactory but a splint was required to correct flexion and ulnar deviation at the wrist

End results On June 19th more than two months after opera tion, the result was satisfactory The thumb index and middle fingers were normal. The palm was supple and painless and flexion at the wrist was not impaired. The little finger however was stiff except at its basal joint and while the ring finger could be fully extended its tip could not be flexed to touch the palm.

Such a result may be considered normal in so far as the little finger is concerned, but it is more difficult to explain the

we should suspect that a phlegmon of the sheath is present, because infections restricted to the cellular tissues never give rise to a large quantity of pus. Lastly, one should think of the possibility of synovial infection, if suppuration persists in spite of efficient drainage of what was thought to be a palmar space infection.

In conclusion, we would emphasise the fact that, in diffuse infections, the clinical signs of phlegmons of the sheath are no longer present, and that a correct diagnosis can only be made by surgical exploration.

Complications

The progress depends largely on the virulence of the infection. In extreme cases, while the palmar collection itself makes little progress, the pus spreads to the forearm and to the arm along the sheaths of the vessels to determine a fatal septicæmia. Medical men appear to be particularly exposed to these virulent infections, which are seen at their worst after post-mortem wounds. The death rate was formerly high from phlegmons of the hand, as we see from the autopsy figures published by Chassaignac and Dolbeau. In Ferrand's thesis, there were two deaths in 17 cases, while my own figures of 39 cases published in 1927 include one death. Patients still die from this cause; in recent years I have known of 3 cases that proved fatal in spite of free incisions in palm and forearm.

Our best results are furnished by the cases of uncomplicated or *simple tenosynovitis*, in which surgical incision of the sheath suffices to evacuate the pus while it still remains localised to that structure.

But, in contrast to this, in *tenosynovites that have become diffuse,* the infection tends to spread, *even after operation,* in those directions we have already studied (p. 261) and figured schematically (Fig. 89).

Spread from one sheath to the other is made manifest by one or other of the signs we have described, but rarely by all.

Spread from the ulnar bursa to the sheath of the ring finger is difficult to diagnose because extension of that finger is already painful in an ulnar bursa infection. Pain in the superior *cul-de-sac* in front of the head of the metacarpal co-existing with a commissural collection is the best sign. In our only case in which this complication arose, the only sign

was flexion of the ring finger, and that persisted even after the infection had subsided On occasion a digital tenosynovitis may clear up without direct incision we have reported several cases (p 207) of this kind, which were simply treated by commissural incisions and through and through drainage the next case was also treated by indirect drainage

CASE 67 (M. Iselin) *Phlegmon of the ulnar bursa complicated by infection of the sheath of the ring finger Interrupted lateral incision Cure with excellent functional result*

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Such a result may be considered normal in so far as the little finger is concerned, but it is more difficult to explain the

partial loss of function of the ring finger Our examination did not lead us to believe that it could be caused by adhesion to the palmar cicatrix, because the scar lay well internal to the tendon We were, therefore, inclined to ascribe it to an infection of the digital sheath This possible complication of an infection of the ulnar bursa is mentioned by Kanavel

Arthritis of the wrist is not always easily diagnosed (*a*) *In its subacute form,* it is shown by *persistent swelling of the dorsal aspect of the hand and wrist,* by continued suppuration and by slight elevation of the temperature (99° to 100° F) Pain on movement of the wrist is not very severe if this sign is elicited with gentleness , while the pathognomonic cracklings in the articulation only appear later

(*b*) In its *acute suppurative form* it can, so far as I am aware, only be mistaken for one other condition, and that is a collection in the forearm in front of the pronator quadratus, in the space of Parona The signs of the two lesions are similar when articular crepitations are lacking, but it is sometimes possible in the latter lesion to perceive deep fluctuation in front of the wrist Lastly, if still in doubt, one should commence the intervention by the latero-ulnar incision (*v* p 286) which will immediately reveal the presence of pus in the deep space

The possibility of this **deep extension to the forearm, in the space of Parona,** should suggest itself to the surgeon as soon as the forearm becomes swollen and painful, either before or after an operation (which did not include exploration of this space) Should a small opening or a median incision already be present, pressure on the forearm will cause pus to escape from it in such large quantity that it could only come from this particular space If a lateral incision has already been made, it suffices to push a curved forceps into it in an upward direction to cause the pus to escape from an insufficiently drained collection

The extensions into the palmar spaces of the hand can be easily detected by surgical exploration, even without anæsthesia The palm, if the infection is restricted to the bursæ, should remain painless and supple on pressure from the second or third day If, on the contrary, it is painful and swollen, then extension has certainly occurred The exact situation of this extension should be sought by gentle exploration through the wound with the point of a pair of smooth-nosed forceps, which will detect the space filled with pus

Commissural and dorsal extensions are sought in the same way, the latter being frequently masked by œdema caused either by a subacute arthritis of the wrist or by an insufficiently drained palmar collection

Prognosis

The prognosis depends essentially on the degree of diffusion of the lesions

When the infection remains localised to the sheaths, it is relatively good since with early intervention, *there is functional impairment of only the finger in which the infection originated* (Kanavel, Lecène) The thumb however will retain some movement under the action of its short muscles whilst the functional loss of the little finger is of less importance

In diffuse infections, on the other hand the condition of the hand after healing has taken place is usually deplorable The wrist is ankylosed and the fingers are all stiff and rigid in the attitude typical of interosseous paralysis The thumb is drawn towards the second metacarpal, so that abduction and opposition are impossible The circulation is impaired the joints of the fingers become ankylosed, and the added trophic changes make this useless hand by turns painful and anæsthetic Nevertheless with energy and perseverance it is possible to regain some slight movements which, by gradual adaptation and skill permit some useful function One of my colleagues operated perfectly in spite of stiff fingers and the celebrated German surgeon Langenbeck is said by Lecène to have been in like manner affected during his youth We shall see that thanks to the incisions we advise the prognosis is no longer so gloomy

Diagnosis

The diagnosis depends essentially on the physical signs the hook sign the shooting pain the small superficial collection in front of the wrist and the deep collection in the forearm

The diagnosis of **uncomplicated tenosynovitis** is easy all the signs are present because the sheath has not burst and the *hook sign* which is most characteristic is easily elicited

It is much more difficult to recognise the existence of a **diffuse tenosynovitis** The hook sign is now valueless as we have seen but though it is lacking one must not infer

that the sheath is intact The shooting pain may well be caused by a superficial subaponeurotic collection, while the little subcutaneous abscess in front of the wrist, to which Kanavel drew attention, has on one occasion helped me to make a diagnosis and on another misled me We have, in fact, seen that a superficial palmar pretendinous phlegmon is often accompanied by a superficial extension in front of the wrist (Case 59, p 245) On the contrary, the existence (when present) of a deep collection in the lower part of the forearm has never failed to prove a reliable sign

In conclusion, we would emphasise *that systematic surgical exploration is the only method by which an accurate diagnosis can be arrived at in doubtful cases* The infected wound is first excised and enlarged, and if the underlying sheath is found to be infected, it is then incised in a manner to be presently described Occasionally, under general anæsthesia, it is possible to elicit the presence of "hour-glass" fluctuation between the hand and the forearm, as Leibovici noted in one of his cases

Treatment

Methods

Certain non-operative *medical methods* of treatment have been greatly extolled Apart from the *passive hyperæmia* (which no one outside Bier's school has found of any value), Delbet's vaccine, propidon, has, in some cases, achieved surprising cures Delbet showed a case of this kind before the *Société de Chirurgie*, and I saw a similar case in Fredet's clinic Although I have had no success with vaccination in my personal cases, I believe that, in such a serious infection, it is a therapeutic agent that should not be withheld, since it may favourably influence the progress of the case by promoting pus formation and its localisation

Surgical Methods. The surgical methods comprise the infinite variety of incisions which have been proposed through past centuries, and which may be classified into two groups in accordance with whether they respect or divide the flexor retinaculum (annular ligament of the wrist joint) The former are *interrupted* and the latter *continuous* A long incision throughout the length of the sheath being described as *antibrachio-palmar*

Interrupted incisions were described as far back as 1745 by

La Faye in Dionis's *Cours d'opération de Chirurgie* without great precision He appeared to make them where the pus tended to point and then passed a seton from one to the other under the flexor retinaculum He proceeds to remark These incisions do not always prevent further complications, which may be due to the severe degree of compression caused by the flexor retinaculum on the underlying structures and in particular on the flexor tendons In some cases it may be advisable to divide the retinaculum, but this leads to grave incapacity and should only be done to save limb or life

Chassaignac favoured the same technique and he also advised division of the flexor retinaculum in case of need

Towards the end of last century the barbarous idea was advocated of forcibly introducing a drain under the flexor retinaculum to connect up the palmar and forearm incisions This procedure was justly described by Picqué as a therapeutic heresy but it was a heresy that long remained current in French teaching (it is illustrated in the Prosectors *Précis de Technique*) and was still advised by Mauclaire in 1912 We have been unable to discover the initiator of this technique which inevitably caused sloughing of the tendons and neuritis of the median nerve by compression in this inextensible canal. In comparison with this deplorable method section of the flexor retinaculum was a distinct progress

The *long median antibrachio-palmar incision* was advocated by Helferich (2) of Vienna as the best method of early *routine* treatment Forsell (3) of Copenhagen also used it extensively and published a series of articles and statistics which proved the excellence of the method especially from the point of view of preventing the more serious complications that threaten the patient's life These articles which were well documented (Forsell reported 60 cases) attracted widespread attention, and in the years that preceded the last war the method gained universal acceptance in Germany in America under Kanavel's and in France through Lecène's influence

The interrupted incisions had remained in favour in France until the publication of the article of my regretted teacher Lecène in which he summed up in favour of the long antibrachio palmar incision His advice however did not gain universal acceptance as Picqué and Descomps in Paris,

and Duvergey of Bordeaux, opposed systematic division of the flexor retinaculum, and published excellent results in spite of its conservation

But surgeons were becoming more critical as to the *quality* of their functional results, and the late results of the long median incision were very unsatisfactory Kanavel was the first to recognise that it should be used only in exceptional and desperate conditions, just as Dionis had advised in the lines quoted above While in Germany the classical works of Zur Verth and of Klapp and Beck formally denounced it and recommended interrupted and lateral incisions



Fig 91 Result of a phlegmon of the ulnar bursa operated on early by Lecene All the fingers function well, except of course the fifth (Lecene)

In the first edition of this work, which was published in 1928, I criticised adversely, for the first time in France, the long antibrachio - palmar incision on the evidence of 40 cases which I had been able to collect I had been persuaded on theoretical grounds of the advantage of the *interrupted and lateral incisions* described in Kanavel's book, without, however, the support of personal experience

By the time my second edition appeared in 1933, my friend Leibovici and myself had operated on 6 cases by that technique and clearly proved its worth Since then I have operated on 12 more cases with most satisfactory results

The interrupted and lateral incisions are characterised essentially by the site of the forearm incision, which opens the space of Parona on the lateral border, either on the ulnar, or radial aspect, *to gain access to the sheath at its superior* cul-de-sac *and on its posterior aspect* The sites of election for the palmar and digital incisions differ with various authors, as we shall describe later

Evaluation of the Methods

Interrupted Anterior Incisions In spite of certain relative and fortuitous successes this method has been abandoned with little regret by the majority of surgeons *because these incisions provide insufficient drainage* and remain burdened by a considerable percentage of septicæmias and arthritises of the wrist Further the drain forced through the inextensible carpal canal causes sloughing of the tendons and determines *neuritis of the median nerve* which by its persistence and severity aggravates considerably the post-operative sequelæ

Median Antibrachio-palmar Incisions *This long incision* which exposes the sheaths in their whole extent realises theoretically the most perfect drainage of the carpal sheaths by completely exposing them The immediate course of the affection was ameliorated and one saw fewer cases of fatal suppurative arthritis of the wrist and extension into the fore arm When these complications appeared however they were ascribed to the particular virulence of the infection or to defective resistance on the part of the patient The late end results were apparently better as neuritis of the median no longer occurred but we were unable to undertake an exact study of these until 1927

Indeed, Lecène (4) in his paper published in 1911 was *more concerned with the immediate result and gave few details* of the exact state of the two patients re-examined after complete healing In one (Case 3) after phlegmon of the two sheaths the little finger was ankylosed in flexion and the thumb so contracted that a secondary operation was required to free it The second (Case 4) in which the lesion was also a total phlegmon, was left with contraction of the little finger The other fingers were described by Lecène as movable with no more details though as the illustration (Fig 91) borrowed from his treatise shows the fourth finger also could not be completely extended.

Ferrand s (5) thesis comprises 17 unpublished cases collected between 1909 and 1912 by Lecène Desmarets Reynier and Chifoliau In 1 case the result following interrupted drainage with insertion of a drain through the carpal canal was deplorable (acute arthritis of wrist which necessitated resection) The other 16 cases were treated by the long continuous antibrachio-palmar incision. In 12 *both sheaths* were infected, in 2 the ulnar and in 2 the radial

The *operative results* were as follows 2 *deaths*, 2 acute arthritises of wrist which necessitated resection, in 3 secondary extension occurred into the hand and forearm

The *late results* are given in 11 of the cases operated on *One perfect result* (Case 9), with return of flexion of the second phalanx of the thumb after phlegmon of the radial sheath operated on by Lecène. *Two good results* (Cases 4 and 6), both being cases of phlegmon of the ulnar sheath followed by loss of function of the little finger, whilst the others functioned perfectly *Three mediocre results* (Cases 3, 5 and 10), of which Ferrand records that extension of the second, third and fifth fingers was normal, but that *flexion was markedly restricted and weak* (*cf* Fig 92) , the thumb could be brought into contact with the index, but not with the third and fourth fingers *Five definitely bad results,* with the wrist stiff and fingers ankylosed and practically useless (Cases 8, 11, 15, 16 and 17)

These results are in every way comparable with those we have ourselves seen, but they mark nevertheless such definite progress over those obtained by the older incisions that the good reputation of the long antibrachio-palmar incision was rather confirmed by this work, as it then constituted the best available technique

In 1927, in the first edition of this book, I published the results of 40 cases of tenosynovitis of the bursæ, 17 of which were derived from the clinics of Professors Lecène, Lenormant and Gosset, to whom I was house surgeon Of these 40 cases, 8 *had been amputated through the forearm* (20 *per cent*) , *in* 5, because of persistence or extension of the infections, generally associated with suppurative arthritis of the radio-carpal joint, and one of these died in spite of amputation , *in* 3, because the hand was completely useless and painful , these "*tertiary*" amputations (Broca and Raoul Monod) were done respectively two, four and five months after the sheaths had been incised Nine only of the remaining 32 cases could be traced and examined Their conditions are given with more detail in the first edition of this book In 2 the late result was very satisfactory , in the remaining 7 the function of the hand was seriously impaired and the disability was assessed at between 40 and 48 per cent

Lecène was surprised by these bad results, and at his request I reviewed, in 1929, the cases more recently operated on in his clinic at Saint-Louis Of the 6 cases of phlegmon of the carpal

sheaths that had been treated by the long anterior incision the results were as follows in 1 the result was good with very satisfactory recovery of function in 1 the result was fairly good as the hand retained slight useful function in 3 the results were definitely bad with disability assessed at 50 per cent in one amputation had been performed for suppurative arthritis of the wrist with septicopyæmia

We did not include in this series a further case which following an accident at work had been operated on elsewhere and which was admitted to Saint Louis with suppurative arthritis Infection and secondary hæmorrhages necessitated immediate amputation of the forearm (case 8 p 3)

In view of this considerable percentage of amputations and permanent disability the result was satisfactory in a small minority only

I have also seen 3 cases operated on by my friends Senèque Soupault and Galtier in which the finger movements had largely recovered Lecène showed 2 good cases before the *Société de Chirurgie* in March 1928 one the case of Braine (6) and the other a private case of his own. Braine s patient at the end of four months was able to make a fist normally all the finger movements were normal the wrist was freely movable and the scar painless To quote Lecène s words Such an excellent functional result may without exaggeration be described as perfect in such a serious lesion as diffuse suppurative infection of the common flexor sheath Lecène s patient had recovered all his movements three months after operation flexion of the wrist was normal and the fingers could be easily flexed and extended except for the little finger which remained contracted in slight flexion as a result of suppurative arthritis of the metacarpo-phalangeal joint Welti (7) too showed a successful case at the *Academie de Chirurgie*

Such successful cases are however few in number and complete recovery of function is quite exceptional The favourable cases in which only the finger chiefly affected remains contracted or stiff are also rare *As a rule the hand remains shrunken and even the middle fingers as we have seen, have lost the greater part of their movements*

These results are slightly worse than those of Forsell who published two groups of statistics The first included 29 cases operated on without division of the flexor retinaculum with 1 death 4 amputations and 0 good results The second series

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Further the median incision is useless to prevent or to treat any retro-synovial extension into the space of Parona as the following case illustrates

A workman was operated on by Mouro for a phlegmon of the ulnar bursa by a long antibrachio-palmar incision which divided the flexor retinaculum The temperature did not however subside and the hand remained very swollen On the sixth day when the patient was sent to me the general condition was very serious indeed whilst locally there was enormous phlegmonous swelling of the back of the wrist with complete fixation of the radio-carpal joint which was thought to be due to suppurative arthritis of the wrist Gentle pressure on the anterior aspect of the forearm caused pus to escape freely from the upper end of the incision. The existence of a retro-tendinous accumulation seemed probable A latero-ulnar incision was at once made (Iselin) under general anaesthesia As soon as the aponeurosis was incised about half a glassful of pus escaped. Exploration with the finger verified that this collection was retro-tendinous and extended for a considerable distance under the forearm muscles Two drains were inserted
The patient slept and next day the temperature had subsided The hand was reduced to one-half of its previous size The incision healed up in twelve days

— (*b*) DESTRUCTION OF THE TENDON PULLEY FORMED BY THE FLEXOR RETINACULUM As soon as the ligament is divided the tendons herniate between the lips of the incision and later tend to exfoliate and slough in some degree The dangers of this herniation were fully recognised by J L. Petit who in the seventeenth century advised that the wrist should be put up in as much dorsiflexion as possible to obviate it

(*c*) SLOUGHING OR ADHERENCE OF THE TENDONS TO THE SCAR OF THE RETINACULUM. The long antibrachio palmar incision which exposes the tendons in their whole extent inevitably condemns them to exfoliation This was described by Lecène to the *Société de Chirurgie* in 1928 in the following words In earlier days it was my practice to prolong the incision as the case might be from the little finger or the thumb upwards into the forearm I then observed eliminations of the / tendons or the formation later of troublesome retracted scars Picqué whose loss we regret had already pointed out that section from end to end of infected tendon sheaths was unnecessary and led to troublesome scar formation He was right At present I agree with him that operation should not

of 60 cases in which the flexor retinaculum had been divided showed 5 deaths, 1 amputation and 33 good results

My own collected cases, the patients I have myself examined and the published results permit me to affirm that, in spite of the long antibrachio-palmar incision, a phlegmon of the sheaths leads to suppurative arthritis of the wrist and amputation in about 20 per cent of cases, and that if the hand is saved it is more or less functionless and even completely useless in about 60 per cent of the cases

Causes of these Bad Results. We can to-day assert that these results are bad, not only because they are inferior to those achieved by discontinuous and lateral incisions, but also because of certain reasons, which can be adduced and which were fully detailed in my first work and in the article that Leibovici and myself published in 1931

These may be briefly summarised as follows —

(*a*) Inadequate drainage is afforded by an anterior incision of the collection in the sheath and still more so of any forearm extension ,

(*b*) Division of the flexor retinaculum destroys the pulley of the flexor tendons ,

(*c*) Complete exposure of the tendons tends to cause sloughing and later adhesion of the tendons to the overlying scar ,

(*d*) The long and retractile scars tend to restrict separation of the fingers independently of any additional adhesions between the tendons

These points may, with advantage, be considered in more detail

(*a*) INSUFFICIENT DRAINAGE An anterior incision opens the sheath at its highest point This is especially true of the ulnar bursa, in which the posterior part only is filled with pus It is an easy matter, by separating the tendons during the course of an operation, to explore and empty the posterior *cul-de-sac*, but, as soon as the retractor is removed, the two layers of tendons fall together again and obstruct drainage from the deeper portion of the bursa The insertion of drains is contra-indicated and Lecène definitely proscribes their use, because they tend to cause pressure sloughing of the tendons

While drainage of the radial sheath may prove satisfactory, it is illusory for the ulnar bursa , its effect is rather to expose the tendons than to open up the synovial cavity

It may therefore be concluded that *division of the flexor retinaculum is in itself harmful because its scar forms adhesions with the underlying tendons and restricts their movements*

(*d*) PROGRESSIVE RETRACTION OF THE SCAR This retraction is particularly harmful because its base becomes adherent to the divided flexor retinaculum whilst its apex drags

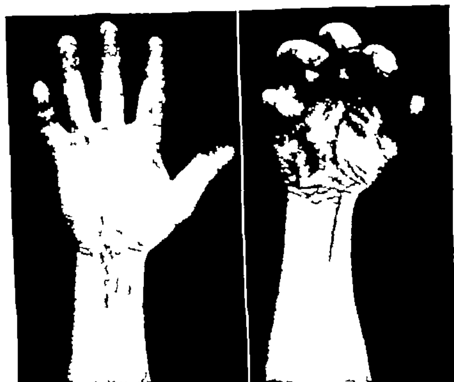


Fig 92. Result of the antibrachio-palmar incision in a phlegmon of the ulnar sheath.

Flexion of all the fingers is arrested midway by adhesion of the tendons to the divided flexor retinaculum.

down either the thumb or the little finger or both when the two sheaths have been opened. In the latter case the hand becomes gutter shaped and progressively more useless.

CASE 71 Octave D aged 42 Operated on April 29th 1925 for total phlegmon (radial and ulnar bursæ) by a long incision with division of the flexor retinaculum identification of the muscular branch of the median and incision of the two bursæ On May 4th a collection was incised on the dorsal aspect of the wrist and then healing took place speedily

Re-examined on August 29th 1925 The condition seemed favourable There was some slight movement of the thumb The

systematically open up the whole length of the infected tendon sheath in its palmar and especially in its digital course It is useless to carry the incisions too far down on the palm and it is particularly dangerous to open up from end to end the sheaths of either the little finger or the thumb" Unfortunately, an incision, even when restricted to 10 or 12 cm in the antibrachio-palmar region, is sufficiently long to endanger the vitality of the tendons or to cause their involvement by adhesion and later in dense fibrous tissue in a particularly vulnerable area. Moreover, *the tendons chiefly affected are those of the middle fingers* which should logically suffer least from the infection This results in loss of function not only of the finger chiefly affected, which is inevitable, but of all the others as well, as the following cases show —

CASE 68 Th was operated on in March, 1925, for a phlegmon of the ulnar bursa by a long incision which divided the flexor retinaculum and which exposed the sheath in its whole extent to the base of the little finger

Re-examined in October, 1926 The fifth finger was contracted and stiff The thumb was intact The index, middle and ring fingers were supple in extension with flexion prevented by well-marked subcutaneous adhesions between the flexor tendons and the divided retinaculum

CASE 69 Phlegmon of the ulnar bursa operated on by the shorter incision that Lecène described to the *Société de Chirurgie* in the lines quoted above The thumb was freely movable and the little finger contracted The other fingers could be fully extended but their flexion was arrested midway by adhesions in the carpal cicatricial block In the photograph (Fig 92) the adherent skin can be seen to be retracted, the palmaris longus tendon stands out in active contraction but the fingers remain semiflexed

The following case offers a contrast to the two preceding ones Movements were possible, for the tendons were not adherent to the resistant ligament, but to the mobile skin

CASE 70 M , aged 20. Phlegmon of the ulnar bursa incised in its whole length with division of the flexor retinaculum on February 24th, 1922

Re-examined on November 7th, 1926 The little finger was fixed in flexion contracture by the scar The thumb was normal Flexion of the other three fingers was satisfactory because they were adherent only to the skin scar, which was movable and which followed them in flexion and extension movements

It may therefore be concluded that *division of the flexor retinaculum is in itself harmful because its scar forms adhesions with the underlying tendons and restricts their movements*

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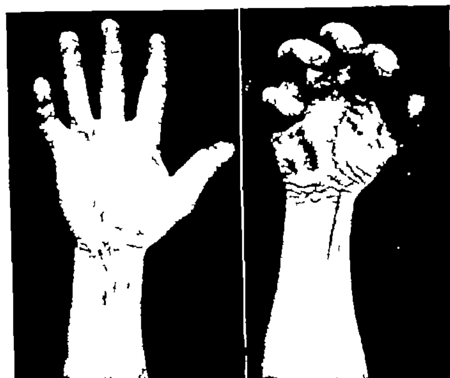


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index, middle and ring fingers were supple and movable The little finger was semiflexed and fixed by a cicatricial band

Re-examined November 14th, 1926 (eighteen months after operation) The result was poor as all the scars had become more and more dense and retractile There was a little movement in the thumb through the action of its short muscles In spite of that the patient was unable to make use of the hand because the wrist was ankylosed in a straight position His disability was assessed at 48 per cent

Interrupted and Lateral Incisions. The interrupted and lateral incisions escape the objections that we have advanced against the median incision

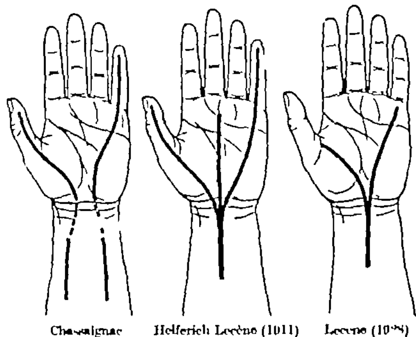
They drain the carpal sheaths better for several reasons they offer a direct approach not only to the deep synovial *cul-de-sac* where the pus chiefly accumulates but also to the retro-tendinous space into which the deep extension spreads (*v* Fig 98) The drainage it affords is dependent, as the patient naturally keeps the hand raised, which favours the gravitation of pus towards the incision For that reason healing of the forearm incision is usually delayed Further, the ulnar incision is dependent in the transverse axis as the patient holds the forearm semi-pronated with the thumb upwards, so that, as we will show later, even the radial bursa is best drained through an incision on the ulnar border of the forearm

Lateral and interrupted incisions *are never complicated by herniation of the tendons* It is well recognised that the prognosis in suture of the flexor tendons has improved since the importance of preserving the pre-tendinous fibrous sheaths has been realised This also holds good in suppurative synovitis, because the "pulleys," which are indispensable to gliding of the tendons, must be spared not only the two pulleys of the digital canal (we have seen that Lecène himself has abandoned complete opening up of the canal) but also that constituted by the flexor retinaculum of the wrist The tendons are not exposed by the ulnar incision and are less liable to slough

Lastly, lateral and interrupted incisions *avoid these formidable retractile palmar scars* which drag down the finger into the palm as in a case of Dupuytren's contracture

Choice of Incisions

The accompanying illustrations (Fig 93) show more adequately than any long description how the principle of



1

2

3

Klapp Kanavel Iselin and Leibovici (1931)

Fig 93 Diagrams of incisions for drainage of the palmar sheaths.
1 Incisions of the ulnar bursa. 2. Incisions of the radial bursa 3 Incision for draining of the deep forearm extension.

interrupted and lateral incisions has been put into practice by various authors.

Klapp remains faithful to multiple bilateral incisions that open up the lateral aspects of each segment of the little finger and thumb He opens the palmar portion of the two sheaths

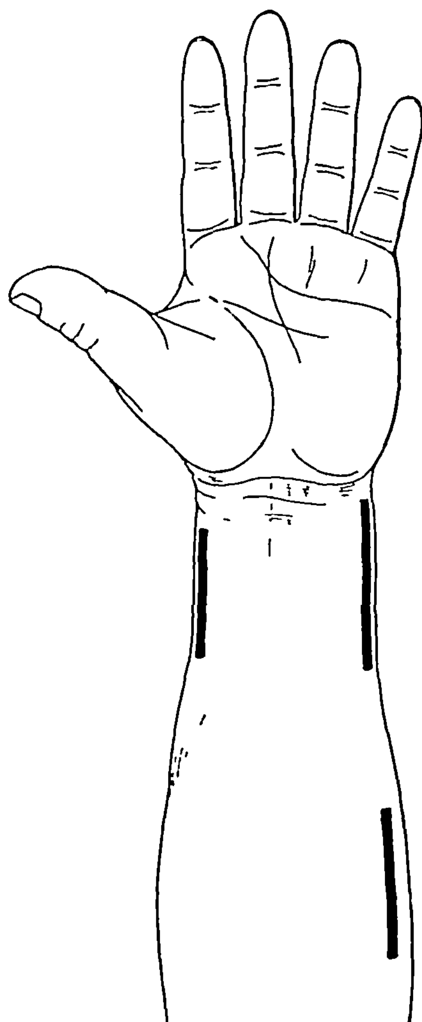


Fig 94 Diagram of incisions for simple tenosynovitis.

One or two drains passed across the space of Parona connect the radial and ulnar incisions (*v* Fig 90) The high ulnar incision should be added when extension has taken place up the forearm between the groups of flexors

by two short incisions made into the proximal part of the palm

Kanavel carries the incision along the whole length of the thumb and up as far as the wrist It is continuous and not interrupted and is liable to leave a retractile scar His incisions on the ulnar side are discontinuous, but the palmar

incision extends from the proximal end of the palm (*talon de la main*) to the commissure of the little finger thus exposing widely the tendon in its whole course

Leibovici and myself in 1930 abandoned opening the digital portion of the sheath in conformity with my views on the drainage of digital tenosynovitis Our results are excellent



Fig 95 Phlegmon of the two bursae of the hand (intra synovial variety)
The superior *culs-de-sac* have been opened in the forearm and the hand maintained in an elevated posture Appearance of the hand on the day after operation (the end-result is shown on p 297 Fig 104)

and we have never had cause to regret not having opened up the finger

For the last three years I have realised that uncomplicated synovial phlegmons and diffuse phlegmons require different operative techniques

Uncomplicated synovial phlegmons only require forearm incisions over the superior cul-de-sac (Figs 94 and 95) It is just as unnecessary to incise the hand as it is to incise the finger For an ulnar bursa infection the ulnar incision

suffices, in a radial bursa infection or with infection of both bursæ, the more important ulnar incision (which affords dependent drainage in the normal posture of the forearm) is first completed and then supplemented by a short radial incision to permit introduction of a through and through drain

On the contrary, a diffuse tenosynovitis always requires

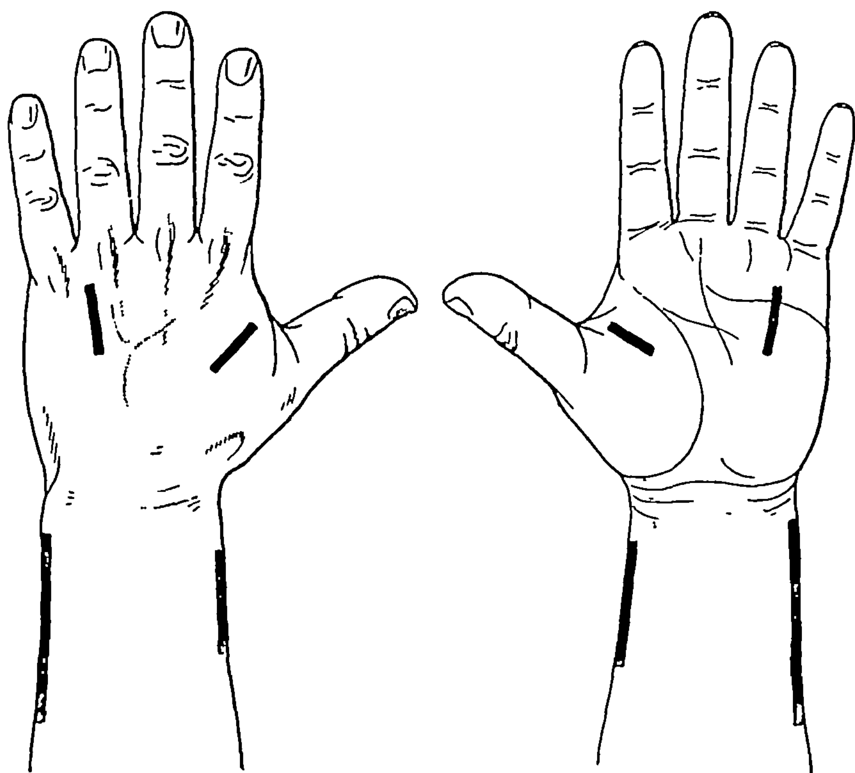


Fig 96 Diagram of incisions for diffuse tenosynovitis

They consist essentially of three through and through drains One in the forearm, the second traverses the fourth interosseous space, and the third transfixes the thenar space (v Fig 97) When the superficial central palmar space is also involved a central incision must be added into the proximal part of the palm and a drain pulled through either to the internal or to the thenar incision

additional incisions in the hand (Figs 96 and 97) An incision into the finger is useless These incisions enable us to insert transfixion drains through the interosseous space between the fourth and fifth metacarpals when the ulnar bursa is involved, and through the commissure of the thumb in infection of the radial bursa If there should also be an extension into the superficial palmar space it must be evacuated by a low median incision

In our experience, drainage of the sheaths is adequately

ensured by these incisions and in the great majority of cases it is unnecessary to divide the flexor retinaculum Kanavel himself as Lecène notes in his article published in 1911 was formerly a partisan of the long antibrachio palmar incision To-day he has abandoned it In the type of case usually encountered the lateral incision gives incomparably better results" He now reserves it for exceptional cases *e g*,



Fig 97 Phlegmon of both bursæ (diffuse form)

All the cellular spaces of the hand and forearm are involved. Note the drains inserted through the space of Parona in the forearm, the through and through drainage of the thenar space, of the median superficial palmar space and of the commissural spaces of the second and fifth fingers.

when the tendons are completely necrosed or when an extensive suppuration has given rise to a collar-stud abscess in front of the wrist or for unusually virulent infections

Our opinion is identical the lateral incisions ensure sufficient drainage when made early and well placed In further support we quote the words written by X. Gellé It is the chief object of this work to show that the prognosis depends less on the length than on the site of the incisions Our researches

confirm and supplement those of earlier writers regarding the restriction of the collections of pus to certain well-defined sites It must be sought there and there only, and long incisions become useless We would, however, emphasise the evil consequences of the *short casual incision* and render due honour to that based on anatomical, physiological and clinical knowledge, which might be called the *short surgical incision* "

Technique

The operation must, of course, be performed under general anæsthesia and after an Esmarch bandage has been applied.

Internal Lower Forearm Incision (*v* Fig 98) A cutaneous incision, 8 to 10 cm in length, is made over the easily palpable border of the ulna This incision should lie more towards the front than the back of the bone and should be too long rather than too short

Its lower end reaches to 2 cm from the ulnar styloid process. A superficial vein is often divided in the subcutaneous tissues, but the dorsal branch of the ulnar nerve can usually be avoided The aponeurosis and the crest of the ulna are exposed with care as they serve as guides to the correct interspace There are, in fact, two distinct aponeuroses covering the flexor tendons and the ulnar nerve and vessels As the classical illustration of Farabeuf, which we reproduce in a slightly modified form, shows (Fig 90), the superficial aponeurosis is adherent to the flexor carpi ulnaris, which gains insertion through it to the anterior border of the ulna , the deep aponeurosis remains separate both from the flexor carpi ulnaris and from the structures it covers, although it also is inserted into the anterior border of the bone Both these aponeuroses must be incised immediately in front of the border of the ulna, along the line of the interspace that lies between the ulna and the flexor carpi ulnaris tendon The wound is then enlarged in an upward direction by detaching the lower fibres of that muscle from their insertion into the border of the bone The flexor carpi ulnaris is then gently retracted and the deeper aponeurosis, which is best marked in the lower part where it forms almost an accessory covering to the deeper portion of the ulnar bursa, is incised The pronator quadratus is then exposed and recognised by the transverse direction of its fibres and the pearly lustre of the tendinous strands of its insertion into the ulna We emphasise these details because

it is *absolutely necessary to get down to the pronator quadratus* (Fig 98)

The correct interspace which lies behind the tendons is characteristic, for the finger tip inserted into it slides over the surface of the pronator quadratus which quilts the interosseous space and can be easily pushed across to the external border of the forearm Pus frequently escapes as soon as the deep space is opened if it has already burst from the sheath and spread into the cellular tissues To evacuate it easily the

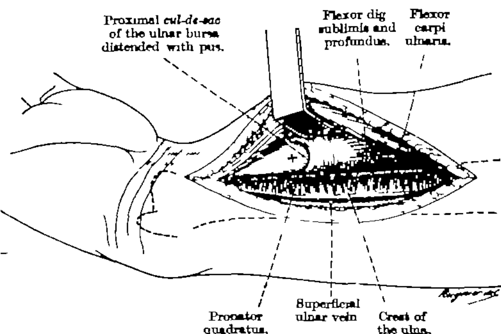


Fig 98 The forearm incision to expose the ulnar bursa

The flexor carpi ulnaris and the common flexor muscles are retracted. Deep to them, the deep aspect of the proximal *cul-de-sac* of the ulnar bursa is exposed.

flexor tendons should be lifted by a retractor The ulnar neuro vascular bundle is neither seen nor endangered because it is displaced forward and protected by the retractor Finally the finger is thrust under the tendons relaxed by flexion of the wrist to ascertain the extent of upward spread and the cutaneous incision is extended as far as may be necessary

With early operation the pus is still within the sheath as in our Cases 4 5 and 6 (1) In that event when the pronator quadratus is exposed and the tendons lifted, no pus is discovered The synovial *cul-de sac* must then be exposed and opened One must bear in mind that the *cul-de sac*

extends upwards to a varying extent in different subjects If well developed and distended with pus, it is recognisable in the depths of the incision and can be opened in full view When, however, the sheath is short and hardly extends above the carpal canal, it cannot be seen even by prolonging the incision downwards to the head of the ulna The finger tip pushed down towards the carpal canal can, however, easily feel the tense *cul-de-sac*, which bulges when pressure is applied to the

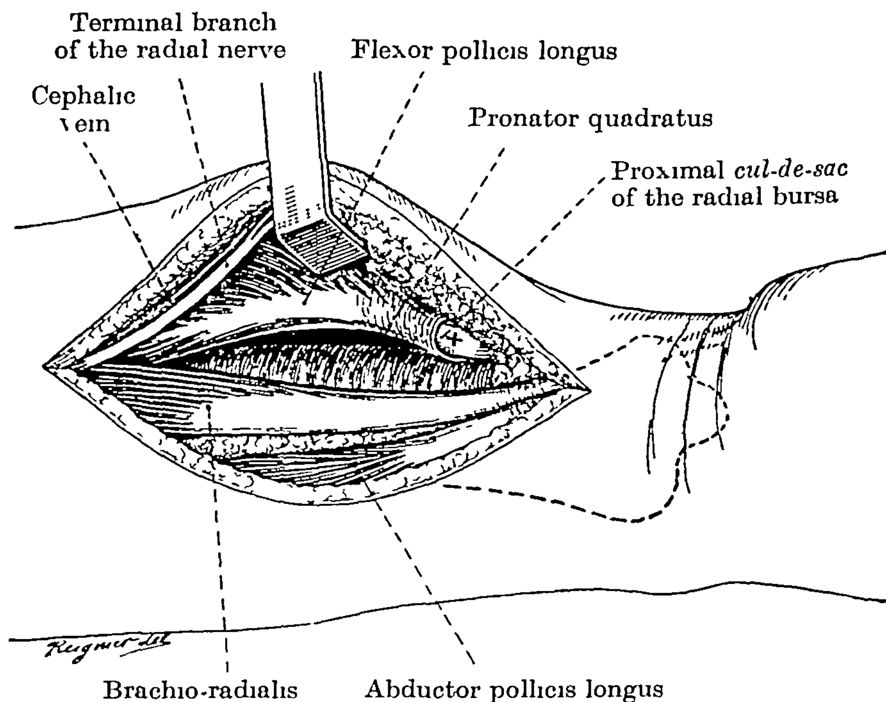


Fig 99 The forearm incision to expose the radial bursa

The lower lip of the incision has been purposely retracted to expose the brachio radialis and the anterior border of the abductor pollicis longus The flexor pollicis longus is retracted to expose, on its deep aspect, the proximal *cul de-sac* of the radial bursa

palmar pouch, and which must be opened with a thrust of a curved director Care must be taken to make this opening sufficiently large to furnish adequate drainage Drainage is best ensured by a rubber strip or one half of a medium-sized drainage tube split lengthwise

External Forearm Incision. This incision is made on the radial border of the forearm (*v* Fig 99) To avoid the radial artery and the abductor pollicis longus, care must be taken not to carry it further down than 3 cm above the radial styloid The cephalic vein and the terminal branch of the radial nerve should if possible be avoided The superficial

aponeurosis is incised along the anterior border of the brachio radialis The incision should not be carried too superficially because that would endanger the radial artery In this situation also *we seek to expose the pronator quadratus* which is still covered by the deep aponeurosis The external border of the flexor pollicis longus is exposed just below its last fibres of origin from the radius This border is freed and retracted inwards with the radial artery There also the pus as with the ulnar bursa has generally become diffused in the retrotendinous space In some cases however it is necessary to evacuate a collection of pus that has not yet burst the sheath This radial incision in itself is insufficient because it does not furnish dependent drainage in the normal position of the hand and the *ulnar incision described above must always be added*

This can be done by cutting down on the points of a pair of forceps pushed across transversely in front of the pronator quadratus till they project as a guide under the skin on the ulnar border When however the phlegmon of the sheath has obviously become diffused into the forearm one should commence by making an ulnar incision of sufficient length because it furnishes more efficient drainage and then add a radial counter incision of moderate size

The ulnar palmar incision, 2–3 cm in length is made in the fourth interosseous space across the palmar flexion crease its lower extremity should reach down to 1 cm. from the web Forceps are then passed through the interspace from front to back and the projection of its points cut down on to make a somewhat shorter dorsal counter incision A through and through drain is introduced and remains in place to drain any dorsal extension if such should be present

Thenar Incision The opening is made into the thick of the commissure of the thumb mid way between the internal border of the thenar eminence and the base of the thumb A forceps is pushed directly backwards through the incision till the dorsal skin projects and then cut down on A through and through drain is inserted to evacuate the palmar and any dorsal collection

The Median Palmar Incision This is made 4–5 cm in length in the middle of the palm The palmar aponeurosis which is altered in appearance is incised and the pus found underneath it Search should then be made for any extension

towards the commissure of the thumb or into the forearm, and if need be these also should be drained by short incisions made as shown on p 238 (Fig 79)

These remarks are only applicable when the presence of a diffuse tenosynovitis has been determined at the initial operation It may however happen that the presence of extensions has not been recognised or that the synovial infection has become secondarily diffused, and these must then be watched for and treated if they should develop during the progress of the case One or more of the extensions we have described developed and had to be opened later in 3 of the 6 cases that Leibovici and I published

Post-operative Treatment

In the majority of cases cure ensues after the sheaths and the extensions have been opened The hand should be completely immobilised in the position of function on a wire mesh splint incorporated in the dressing The temperature falls rapidly and should reach a normal level in four to six days

The dressings are changed but seldom (once a week for example) in the case in which the temperature comes down satisfactorily If, on the contrary, there is a further rise in temperature with return of pains, the dressing should be removed at once to permit inspection We would again emphasise the importance of *absolute immobilisation of the hand in an elevated position to keep the forearm incisions dependent, because we regard this as essential to ensure a successful result*

The drains are removed about the fifth or seventh day, and then after the hand has been dressed it is again splinted and immobilised for several days longer Mégnin and myself showed a case before the *Société de Chirurgie* in which the dressings had only been changed thrice in seventeen days It was a radial tenosynovitis with diffusion into the forearm in which healing took place with complete recovery of function, in spite of the fact that the patient was fifty-two years of age

Search for Extensions

Should the temperature not subside after intervention and the hand remain swollen and painful or should secondary hæmorrhages occur, the cause is not necessarily insufficient

drainage of the sheath but more likely an *extra-synovial extension to the cellular spaces* which must be systematically sought for

We have detailed on p 200 the clinical signs that assist us to detect the site of the infection certainty can however, only be reached by exploring the incisions with curved forceps combined with judicious application of pressure which causes pus to exude and which indicates the direction of any extensions

Extension into the Forearm. It has sufficed in our cases to push a pair of forceps through the low forearm incision, in an upward direction towards the elbow to permit the escape of pus from the space between the flexor muscles In two of these cases a drain pushed up from the low incision caused the complication to clear up In the third case it was necessary to make an additional high lateral forearm incision to drain the space directly and thus ensure sufficient drainage

The primarily infected bursa must of course also be treated by the incisions already described Sometimes as in our second case (1) the two forearm incisions are made first and the operation completed by the appropriate palmar incision

Extension into the Hand. Here also the direction of any extension is determined by exploration If the pre tendinous space is infected, the spread is usually towards the thenar eminence A counter incision into the commissure of the thumb will then be necessary with insertion of a through and through drain between the two Should the collection be retro-tendinous (following infection of the ulnar bursa) the pus is easily found by exploration through the palmar incision, and a strip of rubber is placed behind the tendons Lastly if the pus is dorsal a dorsal counter incision usually suffices to effect through and through drainage as previously described If the whole of the back of the hand is involved the extent of the pouch is ascertained with forceps inserted through the commissural incision and one or more counter-openings then made into its lateral limits and drained by rubber strips pulled through from one incision to the other

Subacute Arthritis of the Wrist Joint. *Plaster* must be applied as soon as the arthritis is recognised A simple metal splint is quite inadequate A plaster slab is applied on the dorsum and sides and is made to overlap the anterior surfaces of the forearm at its proximal end and the heads of the

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metacarpal at its distal end The wrist is, of course, immobilised with the hand in dorsal flexion The plaster is retained till all fever and swelling have disappeared When the wounds are healed, the original plaster can be replaced by one that will more completely support the hand and wrist, as for fracture of the lower end of the radius

Acute Suppurative Arthritis. The fever, pain and local signs demand active treatment, the choice of which lies between resection by the dorsal (Ollier) or lateral (Morestin) routes (8) and amputation through the forearm

Resection should always be tried if the general condition permits, although the results are not always satisfactory It

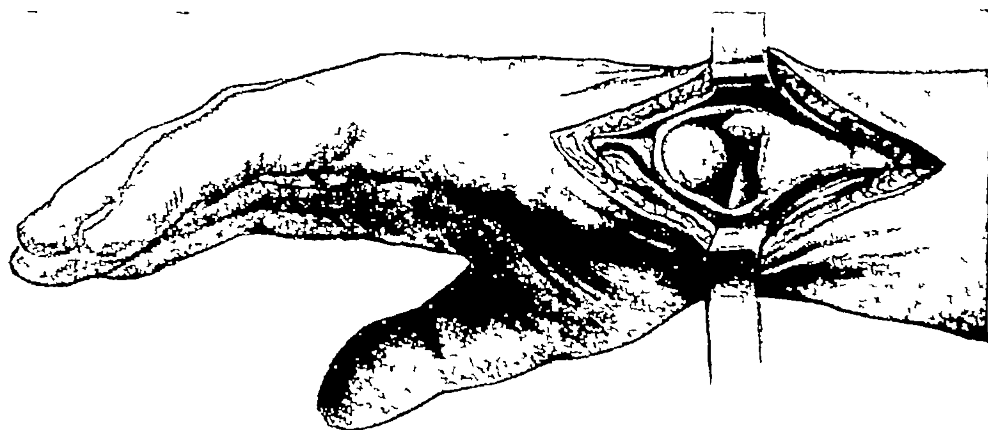


Fig 100 A free exposure of the radio-carpal joint is afforded by the ulnar incision of Morestin between the ulnar tendons (Lecene) , this exposure permits of radio-carpal resection (after Iselin)

may be performed through a dorsal incision, which is the classical one and which was described by Ollier, or through a lateral approach The latter is very easy and I have had the opportunity of doing it once under the guidance of Lecène (*v* Fig 100) A radial counter-incision should also be made and a through and through drain inserted Plaster should be applied as soon as possible, but to start with the hand is put up on a " cock-up " splint to keep the wrist dorsiflexed

Amputation, when necessary, should be as low as possible, that is to say, rarely above the middle of the forearm Antero-posterior flaps are fashioned by two lateral incisions and stitched loosely It is advisable to identify and ligate the ends of the nerves, then to inject alcohol above and divide below the ligature to prevent formation of painful neuromata

Secondary Hæmorrhages Secondary *hæmorrhages* are always evidence of bad drainage or of persistence of the infection from bad general condition They are rarely abundant at the outset, and commence as slight warning bleedings which are checked by plugging the wound The occurrence of such premonitory bleeding calls for careful examination of the wound (under general anæsthesia) with exploration of any possible extensions enlargements of incisions, etc

When severe hæmorrhage takes place, *a tourniquet must be immediately applied* and kept on till the patient is in the theatre and anæsthetised The blood pressure is taken and if necessary saline, adrenaline or transfusion given to raise it

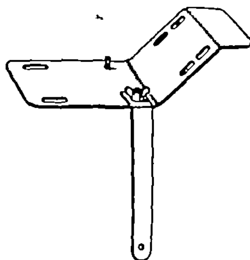


Fig 101 A cock-up splint to correct the position of the hand and to immobilise it in the position of function.

Never operate on a patient thus infected if the blood pressure is low as he will surely die on the operating table When the blood pressure has been sufficiently raised he is anæsthetised (preferably by a small dose of evipan of 4 or 5 c c) followed by intravenous saline administered through the same needle After removal of the tourniquet the wound is cleaned out and search made for any arthritis overlooked extension or sloughing tendon An attempt is made to identify the bleeding vessel and to ligate its two ends when found The enlarged incisions are then packed with gauze Lecène advocated the use of an antiseptic and recommended iodoform gauze for the purpose and I have always remained faithful to his teaching

Sinus Formation When the temperature does not subside

metacarpal at its distal end The wrist is, of course, immobilised with the hand in dorsal flexion The plaster is retained till all fever and swelling have disappeared When the wounds are healed, the original plaster can be replaced by one that will more completely support the hand and wrist, as for fracture of the lower end of the radius

Acute Suppurative Arthritis. The fever, pain and local signs demand active treatment, the choice of which lies between resection by the dorsal (Ollier) or lateral (Morestin) routes (8) and amputation through the forearm

Resection should always be tried if the general condition permits, although the results are not always satisfactory It

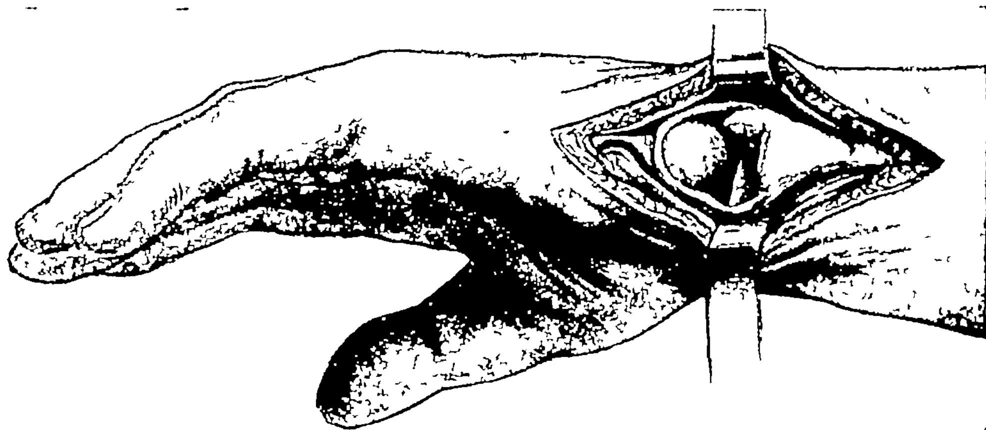


Fig 100 A free exposure of the radio-carpal joint is afforded by the ulnar incision of Morestin between the ulnar tendons (Lecene), this exposure permits of radio-carpal resection (after Iselin)

may be performed through a dorsal incision, which is the classical one and which was described by Ollier, or through a lateral approach The latter is very easy and I have had the opportunity of doing it once under the guidance of Lecène (*v* Fig 100) A radial counter-incision should also be made and a through and through drain inserted Plaster should be applied as soon as possible, but to start with the hand is put up on a " cock-up " splint to keep the wrist dorsiflexed

Amputation, when necessary, should be as low as possible, that is to say, rarely above the middle of the forearm Antero-posterior flaps are fashioned by two lateral incisions and stitched loosely It is advisable to identify and ligate the ends of the nerves, then to inject alcohol above and divide below the ligature to prevent formation of painful neuromata

The hand has been seriously damaged little movement remains in the fingers the forearm is atrophied and the joints stiffened Improvement can however be effected by regular exercises massage and manipulation but especially by *active movements* of the fingers joint by joint Progress is slow to begin with but increases progressively with purposive function and in favourable cases complete recovery may be achieved In many of the cases I have operated on, the scars alone remain as evidence of the past infection

Results

The number of patients operated on by these methods is not large because in modern times we fortunately do not see many cases of phlegmons of the sheaths Leibovici and myself published our first six cases in the *Journal de Chirurgie* in 1931 Two more were added in the 1933 edition Since then Mouro s (9) report to the *Société de Chirurgie* in February 1934, comprised 8 cases one of which was from Rumania (Costescu and Tudor) (10) I have since then operated on 5 cases 3 of which were published in X. Gelló s thesis Altogether 21 cases whilst Bonnet (11) has published 2 cases

I attach great importance to an exact classification of the results which may be grouped as follows —

Perfect Results Return of flexion and extension in all the phalanges of all the fingers

Good Results Only the finger in which the infection originated remains stiff Kanavel and Lecène considered this an excellent result

Mediocre Results in which the movements of the ring and little fingers are limited

Bad Results The other fingers and the wrist are stiff with disability rarely less than 40 per cent

Our 21 cases comprise 7 perfect results 8 good, 3 mediocre 2 bad and 1 death

The bad results were in subjects aged 52 and 56 years and the death (in diabetic coma *v* Case 11 p 6) was that of a man aged 61

In comparing these results with those following the anti-brachio-palmar incision of which there are still many partisans in France isolated cases only should not be considered. The various published statistics (Ferrand Iselin, 1928, Lecène

completely and suppuration persists from one or other of the incisions, it may be assumed with certainty that it is due either to sloughing of a tendon, or to a suppurative arthritis. The tendon may be that of the little finger or of the thumb, while the wrist or the metacarpo-phalangeal joint of the little finger are most frequently infected, in the latter case, it is better to perform disarticulation



Fig 102 Phlegmon involving all the sheaths

The end-result is perfect in the thumb and middle fingers Flexion of the little finger is defective

If the wrist joint is involved, it is usually a subacute arthritis that will end in ankylosis, if treated by prolonged immobilisation, the best result under the circumstances

Re-education

As immobilisation is essential in the treatment of these infective lesions, mobilisation of the hand and finger should not commence till the infection has completely subsided

Due weight can only be attached to the words of even such an important tribune if the convictions they express are supported by facts The lesions and clinical cases in which short incisions are justifiable and those in which long incisions are indicated must be precisely defined It would also be

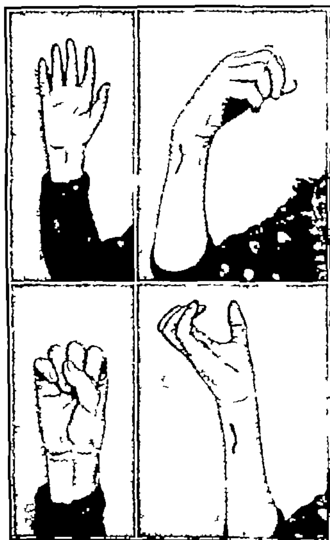


Fig. 104 Phlegmon of both sheaths of the hand
(Case shown in Fig 95 p 183.) The result two months after operation.

desirable to know the number of cases studied and how the results on which such conclusions are based were arrived at In the absence of this precise information such statements are devoid of any practical value

The essential and most difficult principle in our view con

and Iselin, 1929) give 25 per cent of satisfactory results with a 10 per cent mortality and amputation in 20 per cent

The question would appear to be settled on these figures alone, and yet habits persist with such force that many French surgeons still imagine they are "saving the patient's life" by dividing the flexor retinaculum and believe that they incur

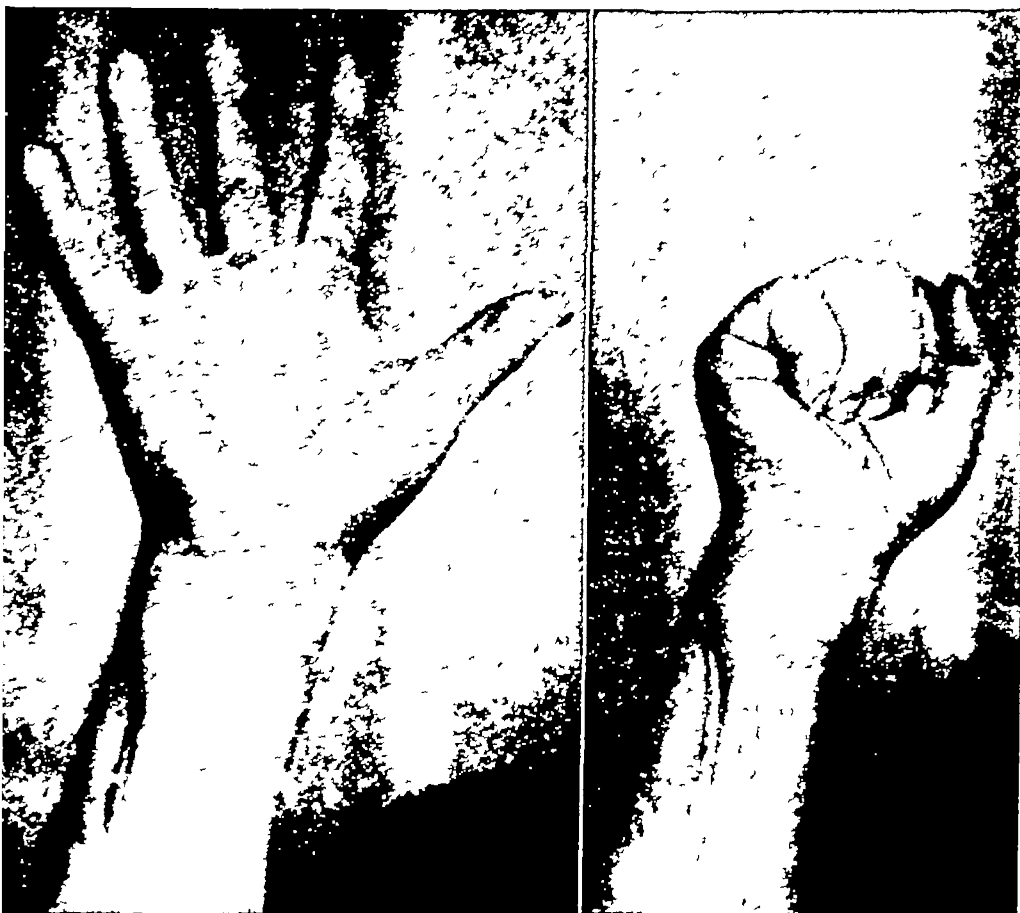


Fig 103 Phlegmon of the ulnar bursa

Perfect functional result from the second month Flexion and extension of all the fingers, including the little finger, are normal (R Leibovici)

serious responsibility if they omit this step, which they regard as an almost routine practice

The following words, used at the *Société de Chirurgie* in 1934, appeared to express the average opinion of the members of that assembly "While in some cases localised incisions may suffice, there are, *in my opinion, other and much more numerous cases*, in which the anterior methods that consist in very long incisions should still be employed" (E Sorrel)

Due weight can only be attached to the words of even such an important tribune if the convictions they express are *supported by facts* The lesions and clinical cases in which short incisions are justifiable and those in which long incisions are indicated must be precisely defined It would also be

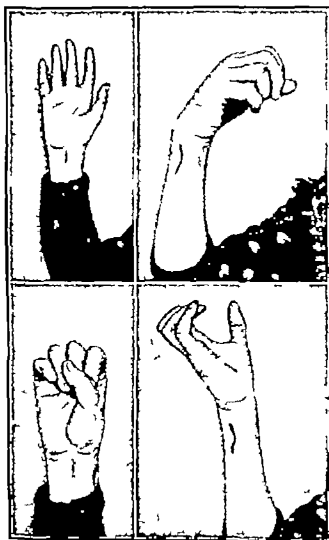


Fig 104 Phlegmon of both sheaths of the hand
(Case shown in Fig 95, p 283) The result two months after operation.

desirable to know the number of cases studied and how the results on which such conclusions are based were arrived at In the absence of this precise information such statements are devoid of any practical value

The essential and most difficult principle in our view con

sists in detecting and opening up any extensions that may be present either during or after intervention It is obviously a more simple matter for the surgeon to divide the flexor retinaculum, then to say that everything necessary has been done and to hope for the best

The defence of the organism is an essential element in all infections and one that is beyond the surgeon's control No one can hope to save a patient suffering from grave septicæmia even by wide and early exposure of the flexor tendons *The surgical intervention has the modest aim of evacuating any purulent collection that may be present This evacuation must be sufficient to permit of the free escape of the pus, but it should not carry infection into healthy tissues nor damage any important structure*

For those reasons it is not only dangerous (as those who advise it recognise) but useless to open up the tendon sheaths from end to end as a routine procedure, because pus is only found in certain limited areas The surgeon's ambition should be to make the incisions only in the places where he *knows* the pus will be found, and, by so doing, to secure early cures of an incomparable quality such as our cases have led us to expect

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PART THREE

CLOSED TRAUMATA OF THE HAND AND FINGERS

INTRODUCTION

NOTHING is more exacting than the systematic study of sprains dislocations and fractures of the hand and fingers for each one of these small joints and each one of the little bones may be injured The nomenclature by itself ocupies many pages and is without practical interest

We have devoted long chapters to this study in the *Traité d Orthopédie* (1) and the reader who is eager for full particulars will be able to refer to that But in this book which is destined for practitioners the only point that interests us is their treatment this is why in breaking away from all the didactic practices we have divided luxations and fractures into two simple varieties

Lesions without displacement
Lesions with displacement

Lesions without displacement do not set orthopædic problems for there are no reductions to perform The treatment would always be simple, the prognosis always excellent were it not for the frequency of a redoubtable reflex complication which has been so well demonstrated by Leriche and to which we have devoted chapter VI p 94 As a result of the slightest trauma there may arise a vaso motor disturbance which will in its turn, determine trophic lesions in the bones and the joints hence the stiffness the pains and the decalcification the importance of which is out of all proportion with the insignificance of the causal lesion

Lesions with displacement whether they are fractures or dislocations set a triple problem —

The reduction and immobilisation of the fracture
The maintenance of function of the finger
The avoidance of post-traumatic vaso motor troubles.

A detailed study of these problems will presently be made

sists in detecting and opening up any extensions that may be present either during or after intervention It is obviously a more simple matter for the surgeon to divide the flexor retinaculum, then to say that everything necessary has been done and to hope for the best

The defence of the organism is an essential element in all infections and one that is beyond the surgeon's control No one can hope to save a patient suffering from grave septicæmia even by wide and early exposure of the flexor tendons *The surgical intervention has the modest aim of evacuating any purulent collection that may be present This evacuation must be sufficient to permit of the free escape of the pus, but it should not carry infection into healthy tissues nor damage any important structure*

For those reasons it is not only dangerous (as those who advise it recognise) but useless to open up the tendon sheaths from end to end as a routine procedure, because pus is only found in certain limited areas The surgeon's ambition should be to make the incisions only in the places where he *knows* the pus will be found, and, by so doing, to secure early cures of an incomparable quality such as our cases have led us to expect

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CHAPTER XVII

TRAUMATA WITHOUT DISPLACEMENT

SPRAINS

Frequency All the joints of the fingers may be sprained The joint most frequently affected is in my experience, the second of the fourth finger and the lesion is due to a knock that tends to force the joint into *hyperextension* The next most frequent sprain is situated at the metacarpo phalangeal joint of the thumb and it is caused by *hyperflexion* of this articulation which has very restrained movements

Clinical Features Pain is very intense swelling appears rapidly ecchymosis is exceptional and the loss of function of the finger is very marked during the first day it then diminishes and flexion and extension become progressively normal but the patient has the impression that his numbed finger has lost all suppleness for a long time afterwards

Prognosis The prognosis is guarded only from the point of view of duration It is common for the patient to have pains swelling and functional incapacity for two or three months after these minor traumas This is a fact which must be realised and yet the *restitutio ad integrum* is the rule the only remaining sequel being a slight deformity due to swelling of the joint

Treatment. It is very important to carry out the treatment of Leriche by immediate injection of a local anæsthetic Up to date I have unfortunately been unable to see a patient immediately after the injury, the majority only come three or four weeks later when they discover that the pain and swelling persist but even at that time it is wise to inject novocaine and to advise active movements as soon as possible

The injections must be given with a very fine and short needle 2 to 3 c c of 2 per cent novocaine are injected around each joint taking good care to prick only the dorsal aspect which is much less sensitive than the lateral and palmar aspects At the outset the injections are given daily later

Examination of a Traumatised Hand

It must be clearly understood that a severe fracture of a phalanx may be accompanied by a minimum of clinical signs, and that the consequences which may result from the non-recognition of these small fractures are considerable This is why, in refusing to describe the external appearances of so many of these small lesions, I wish to impress upon every practitioner the necessity of performing a systematic X-ray examination in two planes

The examination of closed traumata of the hand and fingers is a radiographic examination.

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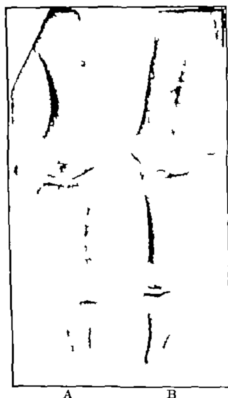


FIG 105 A Olivier Lenoir's fracture (comminuted fracture with compression)
B The result two years later deformity of the head, laxity of the joint, painful chronic arthritis (Male aged fifty years.)

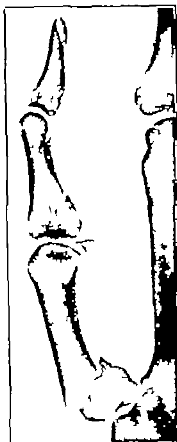


FIG 106 Extra-articular transverse fracture of the first metacarpal Perfect end result

as function returns, they are given with a decreasing frequency

These simple contusions are immobilised for five to ten days, according to the severity of the lesions, but only after infiltration of novocaine, and the latter must be repeated if pain and œdema reappear

DISLOCATIONS

Almost all the joints of the fingers may be dislocated, but, in the majority of cases, reduction is very easy and is, moreover, immediately performed by the patient himself, so that we are then faced with a case of sprain The majority of luxations of the metacarpals fall into this category, with the difference that they are only recognised by radiography and can only be reduced by the medical practitioner The reduction offers no difficulty, it is only necessary to infiltrate novocaine in the painful areas and to pull in the axis of the displaced bone for the latter to fall back in good position We are then faced with a severe sprain As there has been a definite injury to the ligaments, it is wise to immobilise the joint for ten days, but, despite that, one must give injections of novocaine in order to prevent the occurrence of troublesome vaso-motor phenomena

FRACTURES WITHOUT DISPLACEMENT

The frequency of fractures without displacement, or with minimal displacement, is very great in the phalanges and in the metacarpals, in which the direction of the fracture is often longitudinal or spiral, further, a great many lesions result in the compression of the epiphysis against the diaphysis with simple inflexion of the whole bone

All the phalanges and all the metacarpals may thus be fractured, and in the majority of cases they are only discovered by radiography

In the thumb, two varieties of fractures of the proximal phalanx without displacement have been particularised · the compression fracture of the head, called after Olivier Lenoir (1), or "boxer's fracture" (Fig 105), the fracture of the base,

epiphysio-diaphyseal also by compression and known under the name of Rolando

Prognosis

These fractures always unite callus is sometimes abundant but it rarely interferes with the function of the joint or of the tendons

Here again we must repeat ourselves and emphasise the painful and trophic sequelæ The danger is that one may see neighbouring joints becoming stiff and showing decalcification on X ray examination.

In a remarkable little book which appeared in 1935 and which was awarded the Dubreuil prize by the *Académie de Chirurgie* Dr Montant (2) of Paris followed up for a large insurance company two series of patients who had suffered from similar fractures

Before the systematic infiltration of novocaine was adopted by him the period of incapacity was from two to three months and the partial permanent incapacity was from 4 to 12 per cent

Since 1935 all his patients have been treated according to the recommendations of Leriche the duration of incapacity has fallen by ten days to two and a half months and the maximum partial permanent incapacity to 4 per cent the majority of patients having been discharged without any incapacity

The Treatment

Comprises two indications immobilisation and infiltration Immobilisation is *according to Montant carried out with* plaster after the following technique

Our plaster technique consists of a dorsal splint which rests at one end on the distal ends of the bones of the forearm and at the other on the heads of the metacarpals The palmar splint is moulded to the concavity of the palm it rests on the forearm at the same level as the dorsal splint but it stops short distally at the level of the metacarpo phalangeal joints in order to allow for flexion of the sound fingers From the palmar splint springs a gutter splint which will be moulded slowly and progressively to the under surface of the fractured finger while longitudinal traction is effected by wire or strapping and while lateral pressure is applied at the level of the fracture

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The fracture having been anæsthetised one secures the finger to the splint by means of well adjusted bands of strapping without causing any compression The reduction is verified by X rays, and the splint being malleable, can be modified as is necessary

Physiotherapy We quote in full Montant's description of this treatment the importance of which is surely superior to orthopædic treatment in such cases

Physiotherapeutic treatment starts as we have seen, at the time of the reduction by a thorough infiltration with 2 per cent novocaine

It is continued daily by active and passive movements of the sound fingers while one keeps a particular watch on the adequate flexion of the terminal phalanges

As soon as the plaster is removed and before starting the slightest passive movement we perform another infiltration of novocaine at the site of fracture or into the contused area

The infiltration is renewed on the following days, two or three times on an average more often if the movements measured by the goniometer do not improve

One may add to this basic treatment ultra violet ray therapy and hot air baths which are only adjuncts

All rough mecanotherapy must be proscribed for experience shows that all forced movements although they may give rise to an immediate improvement cause a reaction in the soft parts which cancels the temporary improvement

Novocaine infiltrations always shorten the period of functional recuperation, and sometimes even in severe cases the finger recovers its full function two or three days after the removal of the plaster

On an average eight days and two or three infiltrations are sufficient to restore complete function to the finger while it takes at least twice as long without this treatment

Further one nearly always notes the disappearance of vaso-motor phenomena (hyperæsthesia sweating) which are the most tenacious sequels

In order to realise fully the importance of these sequelæ it is necessary to see the patients at frequent intervals One is often astonished to find that many months after the injury vaso-motor troubles (cyanosis) trophic sequels (sweating sometimes dry skin and thickening of the tissues) persist

The traction must be slow and progressive, it is necessary, therefore, that the setting of the plaster should take place slowly, hence the necessity of using thin plaster of excellent quality.

"In short, one must do for the fingers what is done for fractures of the leg after the technique of Delbet. The plaster progressively fixes a reduction which is obtained by continuous traction Later, *not one*, but *several* control X-rays must be taken in the lateral and antero-posterior views If the reduction is unsatisfactory it must be re-started One can correct small deformities by applying more pressure on the hollow plaster splint at the required level with narrow bands of strapping, but it is necessary to verify the results with X-rays"

After-care. "As the hollow plaster splint does not enclose the dorsum of the finger, one can keep an eye on the teguments at the level of the fracture If œdema persists or re-appears during the following days, we perform another novocaine infiltration at that level"

The Duration of Immobilisation. "We immobilise fractures of the proximal phalanx for three to four weeks, according to their severity, fractures of the middle and terminal phalanges for two to three weeks

"Two weeks only, in small juxta-articular fractures, with the exception of avulsion of the extensor tendon, which requires six weeks in hyperextension"

Personally, I have never used plaster for fractures without displacement There are no real reductions to effect, and what is required is simply to maintain the fractured ends in position in order that they may unite and that the patient may not suffer pain

In simple cases I merely immobilise the finger on a 1-mm sheet metal splint, which is both sufficiently rigid and malleable, the splint is moulded exactly to the palmar surface of the injured finger, which must be maintained in the position of function The extremity of the splint must project beyond the finger end, in order to protect the latter from knocks

If the proximal phalanx is fractured, the proximal end of the splint must, naturally, extend to the distal palmar crease which is the flexion crease of the fingers The edges of the splint must be moulded with a pair of pincers to prevent it impinging into the skin, a good precaution also is to cover it, and particularly its edges, with strapping

CHAPTER XVIII

FRACTURES WITH DISPLACEMENT IRREDUCIBLE DISLOCATIONS

WE shall now deal with dislocations and fractures that are accompanied with severe displacements and that are difficult to reduce displacements that entail the use of very difficult orthopædic methods which in my opinion are far from perfect at the present time

To take two examples I have not as yet seen a dislocation of the metacarpo-phalangeal joint of the thumb reduced by the method of Farabeuf (1) It has so far been impossible for me to obtain a perfect result in fractures of the phalanges treated by wire extension after the technique of Böhler a procedure which marks however a considerable progress over all the other methods used previously

One must not be discouraged and one must not under the pretext of our imperfect methods despise those lesions which are so important from the point of view of workmen s incapacity Our methods must be perfected and it is certain that some day we will be able to reduce and immobilise fractures of the phalanges as effectively as we now reduce and immobilise the majority of other fractures

The lesions that present such orthopædic difficulties are not very numerous They are the most commonly seen variety of dislocation of the metacarpo-phalangeal joint of the thumb that is the posterior variety fractures of the shafts of the phalanges and metacarpals fracture of the base of the first metacarpal with dislocation (Bennett s fracture)

DISLOCATION OF THE METACARPO PHALANGEAL JOINT OF THE THUMB

Farabeuf has shown that there are three degrees governed by the position taken by the sesamoid bones in relation to the head of the metacarpal the phalanx is nothing the sesamoids are everything

despite the fact that the finger has recovered full movements, if, apart from physio-therapy, one has not given repeated injections of novocaine."

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strap (the palmar ligament) are themselves on the neck of this bone and consequently behind the articular surface (Fig 108) Naturally the metacarpal head pushes the flexor tendon medially and the dislocation is, consequently said to be postero medial. The opposite displacement postero lateral is exceptional

(c) **Complex Dislocation** The complex dislocation is simply a complete dislocation that has been badly reduced The position of the sesamoid bones on the neck of the metacarpal is the same but the phalanx has been given a longitudinal axis and is still resting on the metacarpal in such a case the collateral ligaments are torn (Fig 109) Vitrac has shown that, in 95 per cent of the cases a lateral displacement is

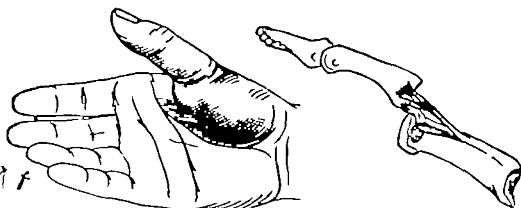


Fig 109 Complex dislocation of the thumb (after Farabeuf)

superadded to the posterior one and that in 5 per cent of the cases only this displacement is postero medial

Clinical Signs

(a) **Incomplete Dislocation** The thumb the deformity of which is so obvious is Z shaped, the proximal phalanx forming an obtuse angle with the metacarpal the prominence of which can be guessed in the thenar eminence The head of the metacarpal is palpable distally and in front under cover of the muscles Functional incapacity is complete but one can easily reduce the phalanx which functions immediately

(b) **Complete Dislocation** The thumb is much more deformed, for the proximal phalanx is at a right angle with the metacarpal and the distal phalanx is also flexed at a right angle There is total incapacity The head of the metacarpal is entirely subcutaneous and the axis of the phalanx is internal

(*a*) **Simple Incomplete Dislocation.** The thumb is displaced backwards, carrying with its phalanx the sesamoid bones united by their inter-sesamoid ligament or strap (the palmar ligament) (Fig 107) The head of the metacarpal is divided

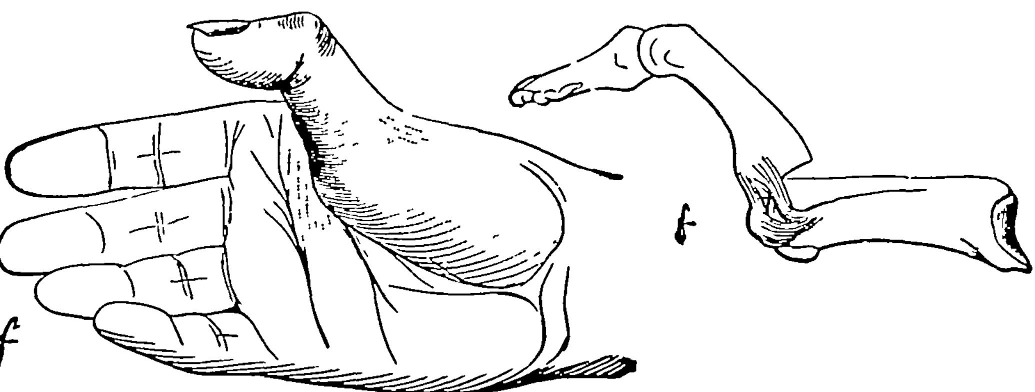


Fig 107 Simple incomplete dislocation of the thumb (after Farabeuf)

into two parts, a posterior part for the phalanx and an anterior part for the sesamoid bones If the metacarpal head is smooth, a simple sprain is the result, for the sesamoid strap falls back into place immediately If, on the other hand, as is often the case, the articular surface is divided into two parts by a transverse crest, the sesamoid strap may get stuck on the phalangeal part, whence it cannot be displaced This displacement only occurs if there is injury to at least one of the collateral ligaments, and, according to Farabeuf, it is usually the external one that ruptures

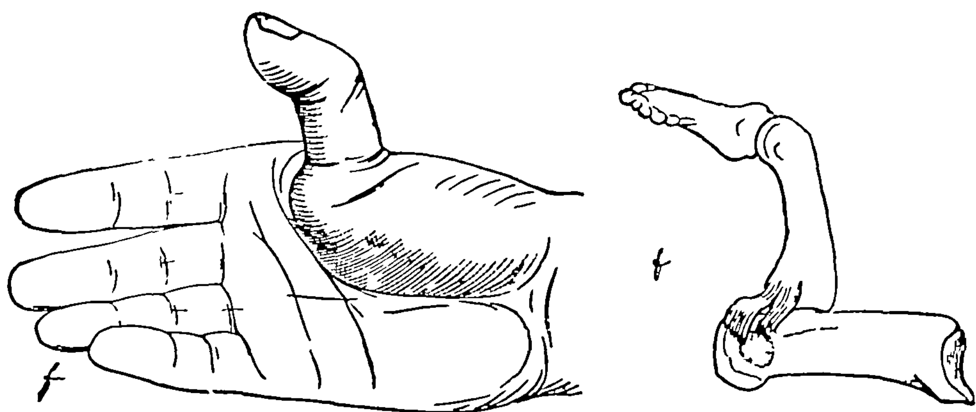


Fig 108 Simple complete dislocation of the thumb (after Farabeuf)

(*b*) **Simple Complete Dislocation.** The displacement here is much more important, and, indeed, the phalanx rests upright on the dorsum of the metacarpal, for the sesamoids and their

Course and Prognosis

What are the late end results of these dislocations? It is probable that some adaptation occurs, but we have been unable to get any precise infomation on the subject Never theless the incapacity and deformity are such that treatment becomes absolutely necessary

The diagnosis is obvious except perhaps in complex disloca tions but here again there is no question of doing without an X ray examination

Treatment

Special orthopædic manipulations are necessary to bring about a reduction, for, as Farabeuf has so clearly pointed out, it is impossible to reduce the dislocation if the sesamoids are not replaced as it is those little bones united to one another by their thick strap (the palmar ligament) which intervene and constitute the irreducible agent

A perfect anæsthesia is of course indispensable It will be by preference local, but there is no objection to a general anæsthesia Here is Farabeuf's procedure of reduction

' Grasp the phalanx which is a perfect rigid lever forming part of the dislocation with this lever provisionally main tained in its semi reduced position for its mobility is its value one will knock against and displace downwards the sesamoids which are stuck on the head of the metacarpal A sudden jolt indicates that one has been successful and this done it s all over flexion of the phalanx occurs sponta neously

If the *dislocation is complete* the principle is the same and one must never exercise traction on a flexed finger or attempt to flex it but on the contrary one must perform the reduc tion, with the thumb in opposition on an uprighted phalanx which will be pulled on while sweeping the bone it will thus meet the sesamoid will sweep it forwards for it is maintained in position by two lips of a buttonhole it will push it on to the cartilaginous margin, and having knocked it overboard the phalanx will follow it instantaneously into flexion

When the *dislocation is complex* one starts by pulling in the axis of the metacarpal one then puts the phalanx at a right angle a manœuvre that carries the sesamoids backwards and upwards and one places the finger edgewise on the carti laginous border on which it (the finger) is made to slide by

to it (Fig 110) Movement can be easily obtained in a lateral direction but is difficult in flexion or extension, for the sesamoid

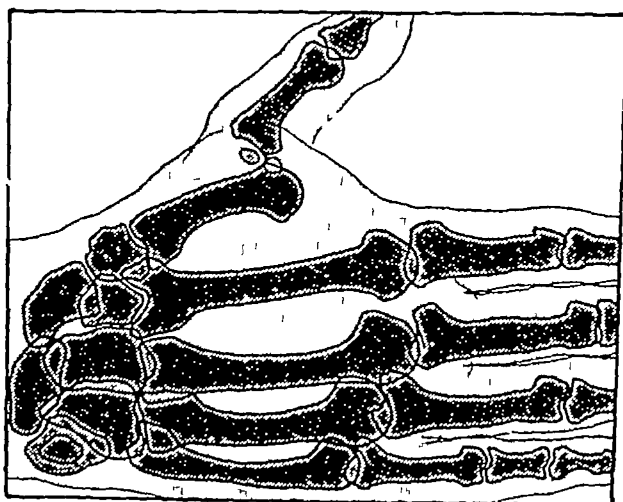
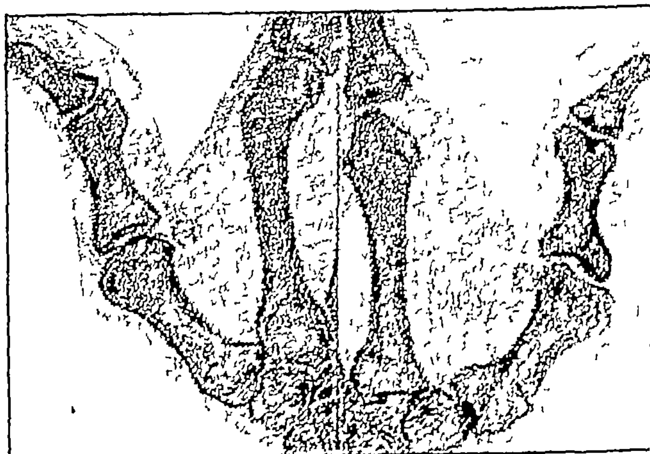


Fig 110 Complete dislocation of the Thumb (after Tixier) Complete interposition of the sesamoid bones

strap (the palmar ligament) prevents it In any case, the deformity immediately returns

(*c*) **Complex Dislocation.** The thumb is swollen, there is little deformity, for the phalanx appears to be in the axis of the





(*a*) (*b*) (*c*)

Fig 111 (*a*) Metacarpo-phalangeal dislocation of the thumb with lateral displacement (*c*) Late end-result showing slight bony deformities compared with the sound side (*b*)

metacarpal, but it is shortened Further, there is an overlap of the phalanx, which is situated either externally or internally to the metacarpal Reduction is possible, but the deformity recurs as soon as the traction is released

Personally we have in one case been successful in performing this operation through a small palmar incision which leads one directly on to the lesions for the dislocated head of the metacarpal is immediately under the skin of the palm

RESECTION OF THE METACARPAL HEAD When the dislocation is irreducible resection of the metacarpal head is then indicated. As a general rule such a decision is taken during the course of the operation for syndesmotomy when one discovers that despite all the sections the phalanx cannot be reduced it is then a case of an old dislocation

The operation is usually performed through the classical incision placed on the dorsal and external aspect (Ollier Polosson) It may also be performed through a palmar approach, which is in my opinion much easier because one comes directly on to the head of the metacarpal The metacarpal is cut through its neck and one must perform a complete resection of the head and must not be afraid to remove more bone if ankylosis is to be avoided Moreover this is of no great inconvenience for the metacarpo phalangeal joint has only limited movements 30 degrees at a maximum

FRACTURES OF THE PHALANGES

Fractures of the fingers with displacement constitute a chapter of traumatology the importance of which cannot be neglected yet in France no comprehensive work has been devoted to them during the last few years apart from the article written by my friend J Courvoisier, and myself in the *Traité de Chirurgie Orthopédique*

It is commonplace to insist on the relative frequency of fractures of the phalanges since radiographic control has become the rule in all cases of trauma But the point that we think ought to be stressed is the relatively serious prognosis of lesions which one might be tempted to treat without any special precautions The bony deformity or even the injury to the joint are factors of lesser gravity than the damage to the flexor tendon and its sheath a complication which has been particularly frequent in our cases and which is aggravated by immobilisation in treatment The consequent blocking of the finger sometimes leads to a very reserved functional prognosis in fractures of the phalanges

We shall endeavour to show in this study the adverse

digging (so to speak) the uprighted phalanx into the metacarpal The dislocation is now simple and complete. one finishes the reduction by flexing the phalanx."

In theory this procedure is simple, clear and logical. In practice it is sometimes difficult to perform successfully Personally, we have seen, as yet, only two cases of these dislocations, and they were both impossible to reduce by orthopædic manipulation To begin with, one cannot get a sufficient grasp of the phalanx, and this is why Farabeuf had had a special pair of forceps made Descarpentries used a small pin passed through the base of the phalanx and was thus able to get a powerful pull to dislodge the sesamoids Then again, when the flexor tendon is on the external aspect of the head, it is very difficult to dislodge it forwards, and this is another cause of difficulty in reduction Nevertheless, one must never omit a serious attempt at manipulative reduction

Surgical Methods

The Dislocation is Irreducible. All the methods described during the last century are now out of date We only mention the cutting of the collateral ligaments, of the muscles and even of the tendons There are only two practical procedures to be adopted, section of the intersesamoid ligament (the palmar ligament) and, as a last resort, resection of the head of the metacarpal

SECTION OF THE INTER-SESAMOID LIGAMENT (THE PALMAR LIGAMENT) was first suggested by Jalaguier, who performed it by subcutaneous tenotomy, a method which is also out of date

The open operation was advocated by Farabeuf "One starts by mobilising the phalanx, in order to rupture any recent adhesions that might have formed One then incises the soft parts over a length of 2 to 3 cm and internal to the extensor tendon, the incision must overlap the dorsum of the phalanx, in order to expose fully the articular ends, which are kept open, and separated by a tenaculum and by strong traction on the bones One now cuts through, with a strong knife and by using the metacarpal as a chopping log, the palmar ligament, between the sesamoid and the tendon, from its attachment with the phalanx to its free border, finally, one displaces the two free borders so made and interposed between the surfaces" (2)

or oblique It would be idle to describe all of them in detail for each type has multiple varieties.

THE DISPLACEMENT The only interesting point is to know if there is displacement and what may be the result thereof Impacted fractures (generally transverse) are not displaced

On the other hand one may see shortening due to overriding in oblique fractures whether the obliquity is lateral or antero posterior and angulation of one or other fragment at the level of the fracture a displacement which occurs mainly in trans verse fractures but also, to a certain extent in oblique and spiral fractures

It can be attributed to the predominance of the extensor tendon over the flexor the extensor pulling the distal end of the distal fragment backwards But the leading part may well be attributed to as Böhler (4) says and illustrates (Fig 112), the



Fig 112. Schematic drawing showing how the direction and tonicity of the lumbricals and interossei pull on the fragments and cause an angular deformity with a palmar projection (Böhler)

tonicity of the interossei and lumbricals which run along the length of the first phalanx and which are astride the dorsum of the second.

This forward displacement of the fragments appears to be the fundamental factor that influences the prognosis and the treatment rather than the simple shortening which is easily reduced

The phalanges like the metacarpals have a slight curve with an anterior concavity which we call the pronator curve The disappearance of this curve and the existence of an angulation of the fragments open posteriorly and with a forward projection, would appear to have a double effect From the purely morphological point of view there comes into being a palmar buffer, which is according to the degree of angulation more or less disabling in grasping Much more important however is the threatened danger to the flexor tendon and its sheath by the palmar projection of the two fragments which are irregular and jagged. We have seen a case of complete subcutaneous rupture of a flexor tendon so

effect of this factor on the prognosis and its practical corollary the necessity for very careful treatment

Frequency

The frequency relative to fractures in general is difficult to appreciate Malgaigne estimated it to be 1 4 per cent , more recently, Plagemann found it to be 5 4 per cent

On the other hand, Ghetti (of Pisa) (3) has just published a paper dealing with 414 cases, from which we extract the following figures regarding their frequency in different fingers and in different phalanges The fingers most commonly affected are in the following decreasing order the thumb, the index, the middle finger, the little finger and the ring finger The proximal phalanx is the most often fractured (53·5 per cent), next the terminal phalanx (30 6 per cent), and lastly the second phalanx (15 9 per cent).

Mechanism and Pathological Anatomy

The morbid anatomy and the mechanism of the lesions afford useful information for the understanding of the prognosis and treatment, and it is entirely from that point of view that we shall study them

We shall distinguish fractures of the proximal and second phalanges from those of the terminal phalanx

Fractures of the First and Second Phalanges

The phalanges are miniature long bones, and it is essential to deal separately with fractures of the shaft and those of the head and the base They are the result of direct or indirect trauma. In *direct* trauma, the shaft is broken and the normal curvature of the bone is abolished In *indirect* trauma, the force is transmitted through the long axis of the bone and fractures are the result of torsion or exaggeration of the curvature

The study of the lesions themselves appear to be of much more importance to us, if they are correlated with the physio-pathological end-results

Fractures of the Shaft. Apart from incomplete or fissured fractures, which may be situated anywhere along the bone, the direction of the fracture is very variable transverse, spiral

or oblique It would be idle to describe all of them in detail for each type has multiple varieties

THE DISPLACEMENT The only interesting point is to know if there is displacement and what may be the result thereof Impacted fractures (generally transverse) are not displaced

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caused, and a case of complete blocking by secondary adhesions A whole series of lesions may be met with between these two extremes

Fractures of the Head and the Base. They are of particular interest because they involve the joint surfaces

(*a*) **Fracture of the Head** This fracture is, in our experience, most commonly seen in the proximal phalanx (Figs 115 (*a*) and 115 (*b*))

Rarely, the fracture is transverse and detaches the two condyles, displacing them backwards to a right angle and dislocating, thereby, the second phalanx on the first

Much more often the fracture is oblique The line of fracture starts on the middle part of the articular surface to finish on the lateral surface of the diaphysis, causing the detachment of one condyle, which is displaced at an angle of 90 degrees, or even of 180 degrees

Sometimes the line of fracture is even more complex and involves the other condyle, which is also detached.

(*b*) **Fracture of the Base.** The most frequent lesion is a fracture that separates a triangular piece, dorsally or more often on the palmar aspect, in the latter case the diaphysis slides upwards and backwards

It must be noted that it is only at the base (Fig 116) and in young subjects that one meets with epiphyseal detachments, but these are unusual cases (Fig 117)

In brief, fractures of the phalangeal extremities are often accompanied by severe displacements angulation of the detached fragment, which points forwards, sliding backwards of the diaphyseal fragment, and thus these lesions very often deserve the name of "fracture-dislocation," which, apart from the articular lesions caused by the displacement, endanger particularly the free play of the tendon in its sheath

Fractures of the Terminal Phalanx

Fractures of the terminal phalanx assume a real individuality on account of the special ætiological and anatomical factors that characterise them

They are caused by two mechanisms A crush, forced flexion, the finger is caught and immobilised at its end while the hand is violently pulled upwards or downwards Each of these ætiological factors accounts for different anatomical features



Fig 113 Comminuted fracture of the proximal phalanx of the thumb with characteristic displacement



Fig 114 Transverse fracture of the proximal phalanx of the thumb with slight displacement Immobilisation on a simple splint End result blocking of the flexor tendon.

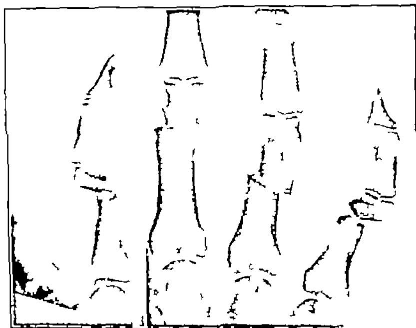


Fig 113 (a) Multiple transverse fractures of the proximal phalanges with slight displacement in the third and fourth fingers, backward angulation of the distal fragment in the fifth finger (best seen in the lateral view) Treated by continuous wire extension (v Fig 113 (b))

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The signs of oblique fractures are less obvious and they are more so as the direction of the fracture approximates to the longitudinal axis of the bone But the pain and the swelling, associated with shortening, suffice to raise one's suspicion, despite the absence of abnormal mobility

In **fractures of the head and the base** the signs are masked by those of an ordinary sprain, except, of course, in those accompanied by posterior dislocation where the diagnosis is easy Articular and peri-articular swelling is very marked, giving a conical shape to the finger Abnormal mobility is sometimes difficult to elicit, but pain on movement and the presence of exquisite tenderness make one suspect a fracture which only the X-ray is capable of revealing

Fractures of the terminal phalanx assume quite a different aspect on account of the ungual lesions

Sometimes the patient seeks advice for a large sub-ungual hæmatoma, which in itself makes one suspect a crush fracture

Sometimes a special appearance is imparted to the lesion by a transverse break in the nail accompanied, in certain cases, by lateral deviation of the finger end In other cases the nail is detached, torn or raised from its base The last two lesions of the nail correspond to fractures caused by forced flexion, involving the middle of the bone in the first case and the base in the second

When confronted with such lesions of the nail, systematic X-ray examination must be performed unless a contused wound necessitates a surgical exploration

In the case of **avulsion of the extensor tendon** the clinical picture is easily recognisable

The patient presents himself with the terminal phalanx in half flexion, and this he is unable to extend, although passive extension and active flexion are possible Strictly speaking, there is nothing which allows one to distinguish clinically between this lesion and the simple rupture of the tendon near its insertion The importance of this diagnosis is insignificant as the treatment is the same

Prognosis

The prognosis of fractures of the fingers bears, unfortunately, no relation to the apparent insignificance of the lesions, and we shall consider it successively for fractures of the shaft,

fractures of the head and the base of the two proximal phalanges and finally for fractures of the terminal phalanx

The prognosis of **fractures of the shaft** is not entirely regulated by the bony injury Indeed, consolidation occurs regularly in about twenty days and to our knowledge pseudarthrosis never occurs But one must fear the possibility of persistent troubles due to callus thick callus and, above all vicious callus formation, which rarely occurs when there is lateral angulation but which is common in cases of angulation open backwards This latter deformity incapacitates much less by the mechanical obstacle that it causes in palmar flexion than by the compression of the tendon sheath interfering with the free play of the tendon even if neither the sheath nor the tendon has been injured at the time of the accident

We arrive at the conclusion that as soon as there is displacement the prognosis of fractures of the shaft is no longer affected by the bony projection but by the condition of the tendon. The latter may be injured or more rarely cut at the time of the accident or at a later stage it may be blocked by callus and, even if the treatment is well carried out and the deformity reduced adhesions will form and will lead to a diminution in flexion from the very moment that the tendon sheath has been torn or contused.

Fractures of the head and the base have their prognosis dominated by the joint damage for here also consolidation is the rule In this respect it is wise to distinguish the cases with gross displacement from those without

If the displacement is slight the prognosis is relatively favourable residual arthritis persists and the joint remains painful and œdematous for many months

When the displacement is severe or cannot be reduced (as in the case of certain fracture-dislocations) the joint always remains partially stiff with persistence of some slight movement The finger is deformed, painful with trophic lesions and it may be necessary to intervene secondarily

Fractures of the Terminal Phalanx. It is amongst these that some cases of pseudarthrosis have been observed a complication which imparts to the finger a sensation of softness, giving rise thereby to difficulty in performing any work requiring precision. We have never seen this complication, but we have on the other hand seen the more common one of exuberant callus which causes pain by encircling the nerve endings and which

sometimes betrays, as we have observed, the presence of an unrecognised old fracture

Apart from these true bony complications, the prognosis of fractures of the terminal phalanx is overshadowed by the fact that they are frequently compound, and that there is a sub-ungual hæmatoma or a rupture of the nail A survey of these lesions has been given in Chapter II, p 44

From the *æsthetic* point of view, the vitality of the nail may be compromised in fractures caused by forced flexion When the matrix remains intact a new nail grows, but when it is injured its blood supply is no longer assured and the loss of the nail is final

Avulsion of the dorsal edge of the terminal phalanx has a good prognosis when judicious treatment is carried out as early as possible Union is then the rule, if not, fibrous union occurs, leaving the terminal phalanx in flexion The incapacity varies a good deal, being much less in those whose work does not entail the use of the fingers

Treatment

Personal verification of the late prognosis of fractures of the fingers has led us to pay particular attention to the treatment In no case should it be neglected, and no one should be satisfied with slipshod methods Anything that is concerned with the function of the hand is of too much importance not to deserve the greatest attention in the choice of treatment and in its conduct and supervision

Methods of Treatment

Numerous methods, from simple immobilisation to continuous traction and open operations, have been advocated

Simple immobilisation is very imperfect because it aims at securing union without attending to the reduction of the deformity It may be carried out on a straight splint or, better still, on a curved metal splint, which secures immobilisation in the position of function

Reduction followed by immobilisation in plaster has also been considered satisfactory by some The displacement is reduced under local or general anæsthesia by traction on the finger, and this temporary reduction is followed by the application of a plaster This treatment is quite illusory, for

the deformity recurs immediately after cessation of traction even if immobilisation is effected by plaster

It is now generally admitted that only continuous traction is capable of effecting both traction and fixation. But in view of the shortness of the article on which traction is effected it is difficult to give a solid basis to this traction. In the French didactic works even the recent ones it is still described that traction should be effected by a loop of strapping or by a silk thread passed through the nail The principle is to immobilise the palm of the hand and the finger on a wooden splint at the end of which a rubber band is placed to maintain traction on the finger

But strapping slips off and requires almost constant care and the splint requires frequent adjustments Then again traction on the nail is very unsuitable (it is painful and the nail breaks etc) Finally movements of the other fingers are difficult and the end result is stiff and painful joints

Japanese finger stalls have been advocated for traction they are plaited rice straws which adhere to the skin and constrict the finger in proportion to the amount of traction exerted They can be employed only in fractures of the proximal phalanx and they are not without danger for if traction is not equally distributed on every part of the circumference of the finger compressive troubles and even bruising may occur

In reality the best method of continuous traction appears to be the one advocated by Böhler and the principles of which are as follows reduction and extension by a rustless wire passed through the pulp of the finger immobilisation on a splint which is bent in moderate palmar flexion, immediate and active mobilisation of all the sound fingers This method has numerous advantages perfect toleration maintenance of fixation freedom of the other fingers and union with the minimum of articular stiffness

Besides these orthopædic procedures operative treatment has its partisans either **simple open reduction or osteosynthesis** The latter is performed either with plate and screws or by nailing the length of the diaphysis after the technique of A. Lambotte If the reduction of an articular fracture proves to be impossible then a resection is the only recourse Finally fractures of the terminal phalanx demand very special treatment which will be fully dealt with.

Amongst all these methods it is necessary to know how to choose the one that is likely to give the best results in each particular case We shall endeavour to give our views on this problem of choice of treatment by drawing, on the one hand, from our own cases and, on the other, from the principles and procedures described by Böhler in his remarkable book

Choice of Methods

It is necessary to deal separately with displaced fractures of the first and second phalanges, and with those very special fractures of the terminal phalanx

Fractures of the First and Second Phalanges

The problem is complex and must be dealt with separately according to the site of fracture base and head or shaft

Fractures of the Shaft. Their reduction necessitates the fulfilment of two conditions the reduction of the overlap and the correction of the angulation

Now, if it is relatively easy to perform the first, it is much more difficult to act against the interossei and the lumbricals, which, as we have seen, are the cause of the angulation

Two methods are to be discussed osteosynthesis and continuous traction

OSTEOSYNTHESIS appears, at first sight, to be the method of choice because it allows for exact reduction and absolute fixation

In practice, however, plating is difficult to perform, the bone is small, correspondingly small instruments are necessary, the cortex is hard and the only accessible part of the bone is the dorsal surface, which is convex in all directions

Two procedures are to be retained wire binding and transarticular nailing They have been perfected by A Lambotte (5), in whose hands they have given excellent results He makes a skin incision along the middle of the dorsum of the first phalanx, and then slits the extensor tendon longitudinally into two equal parts The operation completed, some interrupted sutures of fine silk unite the two parts This trans-tendinous approach gives an excellent exposure and leaves intact the insertions of the lumbricals and interossei on the edges of the tendon

WIRE-BINDING is reserved for oblique fractures The incision is carried over the whole length of the phalanx and

spatulas expose the site of fracture Reduction is obtained by traction on Museux s forceps which grasps the end of the finger across the nail and the fragments are maintained in good position by bullet forceps

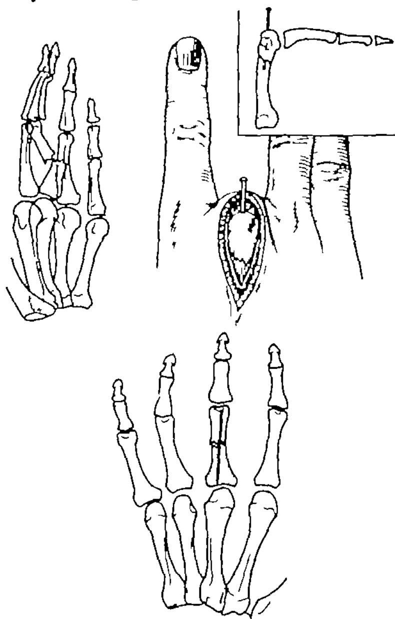


Fig 118 Transverse fracture of the proximal phalanx with displacement treated by nailing (after Lambotte)

Binding is then performed with two wires of $\frac{1}{3}$ to $\frac{1}{4}$ mm diameter passed around each extremity of the fracture with a curved needle Care must be taken, when passing the needle to scrape the anterior aspect of the phalanx in order to avoid

injury to the flexor tendons Active and passive movements are started on the following day

TRANSARTICULAR NAILING is done for transverse fractures The skin incision extends beyond the head of the phalanx to the middle of the distally situated phalanx Section of the tendon opens the dorsal aspect of the inter-phalangeal joint, and by fully flexing the distally placed phalanx, the head of the fractured phalanx is well exposed Reduction is effected by the usual means A nail is then driven longitudinally through the shaft of the bone from the summit of the articular head The nail used is an ordinary nail with a round head and a diameter of 1 5 to 2 mm and of sufficient length so that it penetrates the two fragments to an equal depth (Fig 118) 4 to 5 cm for a fracture of the middle of the phalanx. In order to facilitate its insertion, it is a wise plan to bore a hole through the head with an American drill of smaller diameter than the nail This done, one drives the nail in with light blows of a hammer and the head of the nail beneath the cartilage with a nail punch The soft parts are brought together and movements are started immediately

The latter technique shields the metal better and gives perfect toleration The result can still be improved upon if one utilises, as Lambotte himself does, a magnesium nail which is spontaneously reabsorbed Osteosynthesis thus appears to be, in transverse fractures, much superior to simple open reduction, the result of which is always uncertain

But, whatever procedure is adopted, treatment by open operation exposes the patient to the danger of infection, which is particularly dangerous in these cases, on account of the proximity of the flexor tendon sheath and the joints above and below the fracture And, even if the operation is successful from this point of view, the manipulations, which are always somewhat brutal, and the damage to the soft parts may bring about blocking of the tendon, despite a satisfactory anatomical result

In practice, the open method appears to us as an exceptional one indicated only when a good result cannot be obtained by properly performed orthopædic means

CONTINUOUS EXTENSION is, as a matter of fact, the method which is likely to give the best results with the minimum of risks in the majority of cases We have already shown the difficulties and the shortcomings of traction by adhesive

plaster or Japanese finger stalls The most satisfactory technique is the one that Böhler has so carefully described We summarise it without fear of delving too much into his book



Fig 119 Treatment of a fracture of the proximal phalanx of the fourth finger Dorsal plaster splint applied to the hand in slight dorsiflexion and the finger splint on the palmar side The bent angle of the finger splint lies under the fracture of the proximal phalanx The finger splint is bent so that the two portions are only one finger breadth apart The other fingers can be fully actively extended (after Böhler)

Reduction is performed under local anæsthesia (5 c c of 2 per cent of novocaine injected into the hæmatoma of the fracture) by traction on the finger and counter traction on the upper arm During the maintenance of traction a dorsal

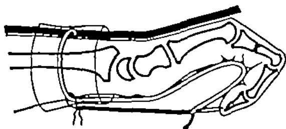


Fig 120 Appliance for a fracture of the proximal phalanx Dorsal plaster splint extending to the knuckles, the wrist being slightly dorsiflexed Finger splint on the palmar side so bent that the knuckle joint is flexed 45 degrees, the mid joint 90 degrees, and the terminal joint 45 degrees. The terminal phalanx then lies parallel to the metacarpal. The wire through the tip of the finger is tied to the end of the finger splint, and this, in its turn, is fastened by soft wire to the base of the finger splint at the wrist (after Bohler)

plaster splint is placed from the elbow to the heads of the metacarpals the wrist being in slight dorsiflexion (Fig 119)

The operator then shapes the finger splint to his own hand in such a way that the thumb can be laid across its concavity and the highest point of the curve will come to lie below the site of fracture (Fig 120) and then applies it to the patient s fractured finger and covers it with a plaster bandage A

rustless wire is passed through the tip of the finger with a needle-holder The two ends of the wire are passed through a piece of wood measuring 1 × 2 cm to separate them and to prevent compression of the pulp of the finger With an awl, a hole is made through the padding at the end of the finger splint The fracture is reduced by longitudinal traction, lateral pressure and by progressive bending over the splint

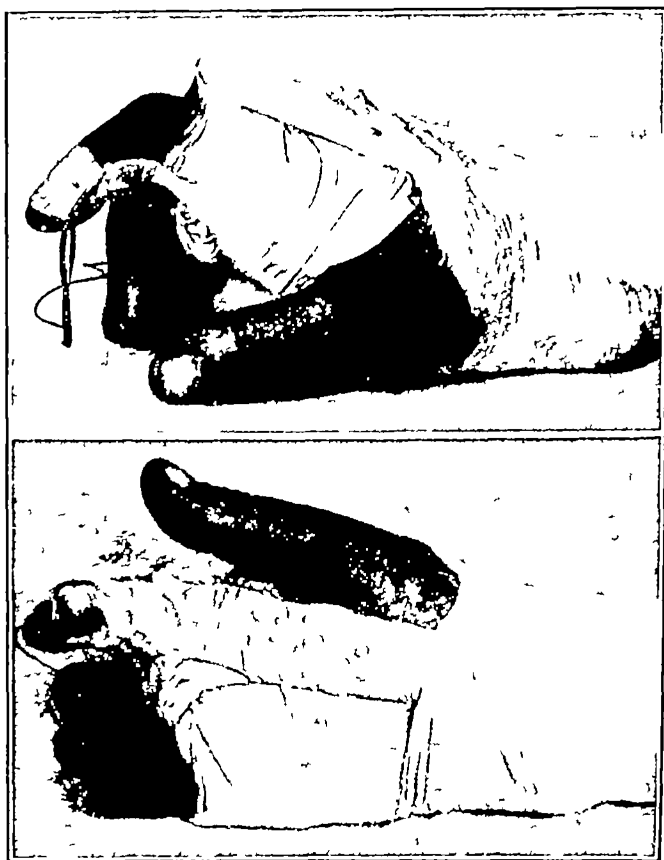


Fig 121 Appliance for fracture with displacement of the proximal phalanx of the index finger Good reduction

The finger wire is passed through the hole at the end of the splint and knotted Care must be taken that too much traction is not used, as this may cause pressure sores on the flexor side This is especially likely to occur if the finger is first placed on the splint in an extended position and then bent " "The finger splint must be so bent that the metacarpo-phalangeal joint is in 45 degrees flexion, the first inter-phalangeal joint in 90 degrees and the second in 45 degrees, the terminal phalanx then lies parallel to its corresponding metacarpal "

' Now X rays are taken. If the position is good the end of the splint is fastened to the wrist by means of soft wire so that it cannot be unbent intentionally or unintentionally thus slackening tension The cast should be so cut in the palm of the hand that the distal palmar transverse crease lies *free*

This fixation allows for flexion extension and spreading out of the sound fingers and these active movements must *start immediately* special care being taken to get full flexion of the terminal phalanges As a result of this *when the cast* is removed *young people can move the fractured finger freely* and old people after a few weeks

Appliances that maintain the finger in full extension abolish this active flexion which is so important Further traction by wire is well tolerated and it is not *necessary to resort to small models of Kirchner s wires and callipers which* have been advised by some

This method when correctly performed appears to be advis able from every point of view, but in conclusion we should like to mention some errors of treatment which according to *Böhler may compromise the end result*

Too short a dorsal plaster splint

Fixing the finger splint to the wrist by an ordinary bandage or leather cuff

Neglect to attach the two ends of the finger splint together with wire

Neglect of control X rays after splinting '

It is now seven years since I commenced to utilise the method of Böhler on every possible occasion I have never been able to obtain the good reductions obtained by its originator as illustrated by his published radiographs This is because his apparatus is not one of continuous extension, for the wire has to be tightened several times a day one must not therefore wait for a delayed reduction to occur when the fracture is not reduced at the time of splinting *Wire extension is in my estimation an excellent method of fixation but only after the fracture has been reduced*

Here is the procedure that I follow at the present moment The plaster and the splint are applied exactly as Böhler describes it I prefer to transfix the pulp with a rustless needle of Lane which is cut off at both ends and to which No 3 silk is tied and maintained in position by two small square pieces

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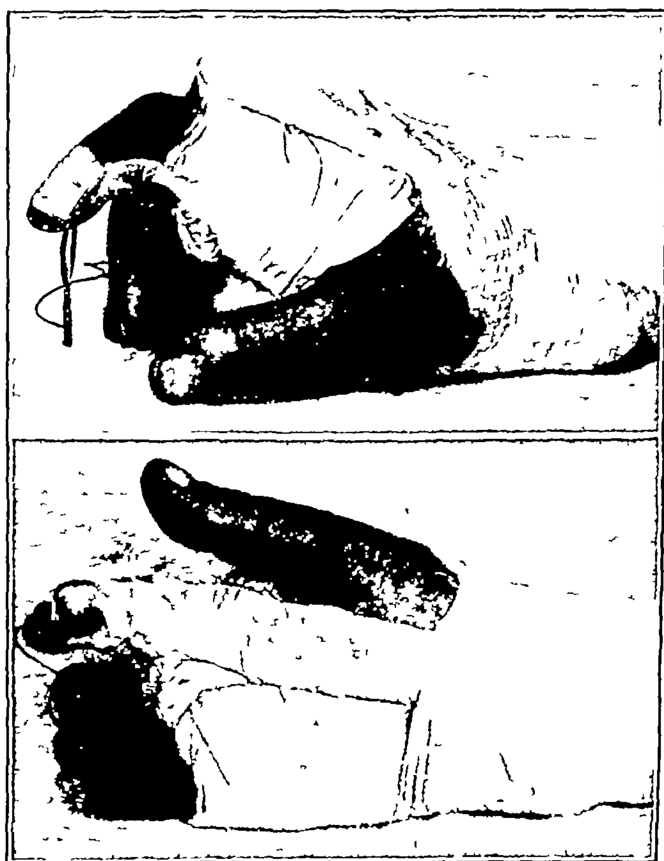


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Fig 1? Oblique fracture of the proximal phalanx with shortening and slight degree of displacement endangering the tendon Wire extension lateral compression with a clothes peg which is put on for one hour three times a day

[To face p 323

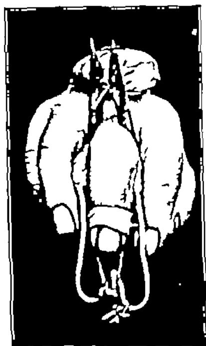




Fig 1?? Oblique fracture of the proximal phalanx with shortening and slight degree of displacement endangering the tendon Wire extension lateral compression with a clothes peg which is put on for one hour three times a day

[T face p 3??.

Fractures of the Terminal Phalanx

The above mentioned treatment is not applicable to fractures of the terminal phalanx purely on account of the architecture of the bone Their treatment is in fact guided by very special indications that vary according to the case They are moreover of frequent occurrence and we will therefore deal very carefully with the treatment

Three varieties are to be considered fractures by bursting fractures by flexion and fractures due to avulsion of the insertion of the extensor tendon

Fractures by bursting are seen in two forms the usual type is one in which a sub ungual hæmatoma calls attention to an underlying fracture the frequency of which is not generally recognised out of 16 cases of sub ungual hæmatoma we found an associated fracture in 4 They are open fractures which unquestionably necessitate an operation on account of the danger of infection and above all on account of the possibility of tetanus as attested by the cases of Berard (v p 38)

But the question of treatment becomes much more difficult when there is no sub ungual hæmatoma and they are the cases in which the fracture may be missed if a radiograph is not taken They are closed fractures in which there is no immediate danger and it is only the possibility of sequels that may lead to an operative decision Now there are two undeniable facts

Although we have never seen pseudarthrosis many cases have been reported in which the finger was deformed at the tip and gave rise to considerable disability in certain professions (musicians skilled workers etc)

Further callus may be painful and exuberant and we know of a case in which persistent pains were only relieved by the resection of the fracture area and the removal of the callus

We therefore advise systematic operation The method of approach to the terminal phalanx is by a lateral incision through the pulp and all loose fragments of bone are removed with a spoon or forceps Primary suture is indicated in this type of case for it reduces the temporary incapacity to about fifteen days

Flexion fractures are also open fractures which demand active intervention

Sometimes the lesion presents the typical clinical picture

the third near the site of fracture These three needles were then interlocked by two wooden spatulas one placed on each side of the finger and through which the needles were passed The reduction was well maintained and the fracture was united in a month when I removed the needles (Fig 123)

The difficulty and danger of conservative treatment compel us to advocate the removal of the distal fragment in cases of works accidents Since all the soft parts are retained the removal of the bony fragment is of little import and the patient rapidly adapts himself to new tactile sensations It is in connection with the nail that the end results are most annoying particularly in women If the matrix is intact the nail will grow again but it will be a little shorter and a little more curved than normal If the matrix is also injured *the loss is permanent* One must be in no hurry and one must wait for the scar to take its permanent shape before trying to improve its ugly appearance by one of the procedures of reparative surgery



Fig 124 Position in which the finger should be held whilst the plaster cast is setting in a rupture of the extensor tendon so as to obtain hyper-extension (after Bohler)

Avulsion of the insertion of the extensor tendon is the last variety of fracture of the fingers to be considered from the point of view of treatment Here both orthopædic and operative treatment have their place

Orthopædic treatment is only of value in recent cases cases seen within hours of the accident Indeed at the end of two or three days the hæmatoma between the fragments organises and makes reduction impossible The treatment consists in immobilising the terminal phalanx in hyper extension for three weeks in order to approximate it to the small bony fragment which is drawn upwards by the extensor tendon.

Hyperextension is effected either by maintaining the finger tightly bound to a simple sheet metal splint raised at its end

of a broken nail The treatment is simple As in the case of the crush with sub ungual hæmatoma, it is only necessary to remove the distal portion of the nail, expose the site of fracture, clean it, remove the loose pieces of bone, dress the wound and immobilise the finger on a splint

Sometimes there is avulsion of the nail the fracture affects the base of the terminal phalanx The problem is more difficult and one may hesitate between conservative treatment with replacement of the nail and ablation of the distal bony fragment along with the nail As far as we are concerned, we reject simple replacement of the nail for two reasons

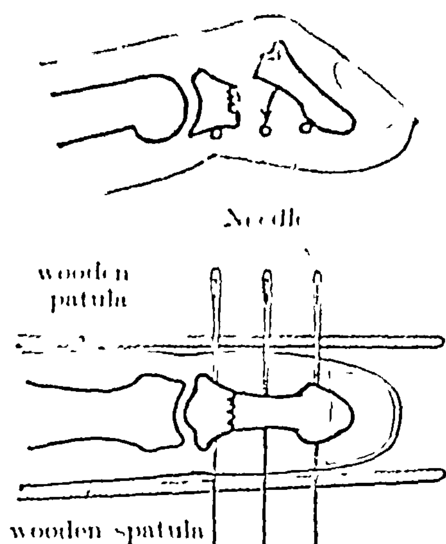


Fig 123 Reduction of a fracture of the terminal phalanx

A needle is passed through the soft parts in front of the base of the bone Another is passed in front of the distal end The fracture is reduced and a third needle is passed in front of the proximal end of the distal fragment The three needles are interlocked by two wooden spatulas through which they are passed

It is most difficult to obtain satisfactory reduction Fixation of the distal fragment is impossible Dorsal pressure applied to the terminal phalanx immobilised on a small palmar splint is an illusory device on a small fragment of bone that slips every time Osteosynthesis is, for its part, practically impossible on such minute pieces of bone

Apart from this question of reduction, conservative treatment exposes this compound fracture to the risks of infection osteomyelitis, prolonged suppuration, loss of the nail and even arthritis

Three years ago I was faced with an epiphyseo-diaphyseal fracture of the terminal phalanx of the thumb which was six days old and not infected , the small diaphysis was displaced, head forwards, and was completely separated from its epiphysis, which was pulled downwards by the long flexor tendon Wishing to retain this phalanx, I adopted the following procedure, which I have not had occasion to use since

The fracture was reduced under local anæsthesia Three Lane's needles were passed through the pulp along the palmar surface of the bone, one near the tip, another at the base and

or, better still, by immobilising it in a finger stall as advocated by Kulenkampf (Figs 124, 125) The finger stall is made with small plaster bandages or with bandages impregnated with celluloid Care must be taken while it is setting to press the end of the finger against some resistant object in order to produce hyperextension If performed within the specified time, this method may give excellent results

Surgical treatment is indicated in all cases in which the above treatment has failed or cannot succeed Böhler expressly advises against intervention for two reasons it is difficult to find anything to suture to on the terminal phalanx, for the periosteum is very adherent, the skin of the region of the nail is very thin and very difficult to suture We have evolved the following technique, which avoids those difficulties



Fig 125 Celluloid finger stall for rupture of the extensor tendon

Do not attempt to suture the tendon, but *re-insert it into the terminal phalanx*

Do not incise on the dorsum, but laterally The incision is made along the edge of the third and second phalanges, it is then curved across the dorsum of the first phalanx to terminate on the opposite side The skin flap thus outlined is dissected, lifted and retracted The end of the extensor tendon is freed, freshened and, with a needle threaded at one end of the suture material, a stay lace stitch is passed through the end of the tendon [1]

A small perforator is now passed through the base of the terminal phalanx and its point is made to pierce the skin on the opposite side "The other threaded needle is passed through the incision and made to appear on the opposite side after perforating the skin through the hole made by the perforator, the latter is now slowly and gradually removed while the needle is pushed after it through the same cutaneous and bony holes There is nothing left to do but to tighten and tie the two ends of the thread, one of which has been passed through the bone A solid fixation is thus obtained, the tendon with its attached bony fragment being firmly fixed to the distal phalanx"

[1] See "Surgery of the Hand," Vol II

Results

The results of this operation have been entirely satisfactory in most cases in some however flexion of the terminal phalanx was limited or impossible the operation having given rise to ankylosis in extension A study of these failures has shown me that they were due to shortness of the re inserted tendon a shortness which is necessary for the correction of the deformity This is why I have since performed in such cases a systematic *resection of the head of the second phalanx* at the same time as the tendinous repair The flexor tendon thus slackened does not pull so forcibly on the terminal phalanx and it is then unnecessary to tighten the extensor tendon so much After four weeks of immobilisation on a metallic splint raised at the end the movements reappear and in two to four weeks they have regained a good amplitude

As to fractures of the phalanges it is difficult to know the results of the different types of treatment described above since no statistics are available Böhler gives no end results and Lambotte only quotes isolated cases Our own cases have been so few that we can only give a series of impressions

It is essential to reduce fractures of the phalanges properly for the results of fractures that are not reduced or badly reduced are deplorable

Böhler s method of continuous traction is very effective but only in maintaining the fracture in position and not in reducing it It cannot however prevent blocking of the tendons for we know of several such cases (Fig 126)

Resections of joints in fractures of the heads of the phalanges give good movement on condition that the resection is wide and that neither the extensor tendon nor the skin of the dorsum is shortened

The question is still undecided, and only a systematic analysis of the late end results of a sufficiently large number of fractures of the phalanges will be able to show us the best type of treatment

FRACTURES OF THE METACARPALS WITH MARKED DISPLACEMENT

(*a*) Continuous extension is necessary to maintain reduction performed under local or general anæsthesia, for otherwise even plaster immobilisation is absolutely futile





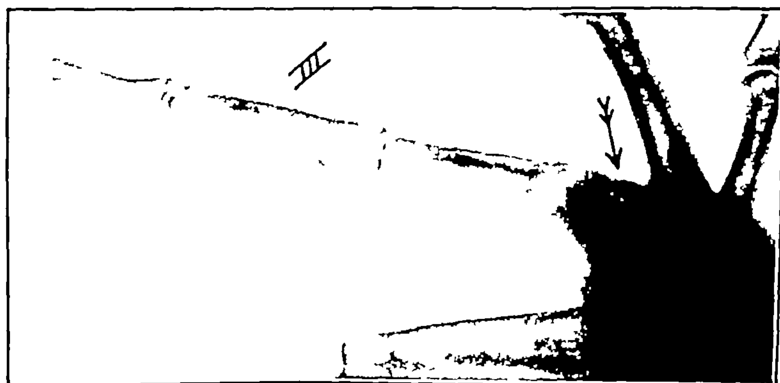


Fig 126 Fracture of the base of the proximal phalanx treated by wire extension The fracture united in perfect position but there was a complete block of the flexor tendons

The method of fixation is similar to that used for fractures of the finger Shortening is abolished by traction on the fingers flexed at the inter-phalangeal joints, while strong pressure is applied on the dorsum to correct the angulation A dorsal plaster splint, extending from the elbow to the

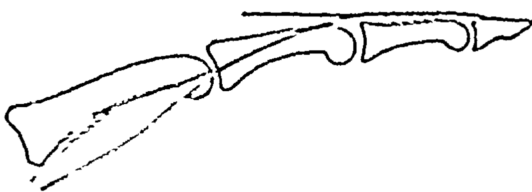


Fig 127 Schematic drawing of the forces acting on the metacarpal and the phalanx The interosseus muscle passes in front of the metacarpal, tending to increase its curvature (after Bohler)

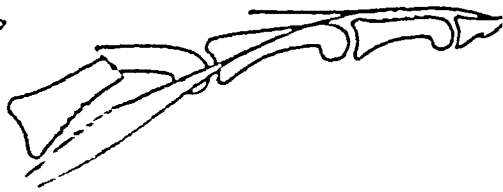


Fig 128 In a fracture, the tonicity of this muscle produces a backward angulation of the two fragments (after Bohler)

metacarpo-phalangeal joints, is then applied and slight pressure is exerted on it so as to depress it at the level of the metacarpal fracture

The pulp of the finger is transfixed by wire and the finger is placed on a finger splint, which is fixed to the dorsal plaster slab The finger splint has been so bent that the metacarpo-

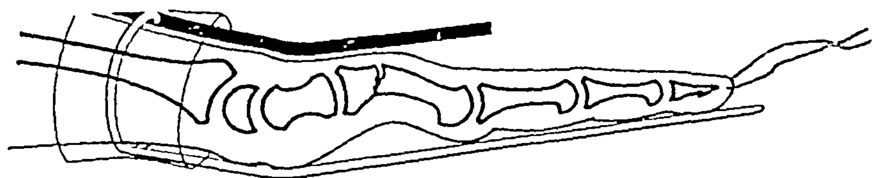


Fig 129 Appliance for a fracture of the metacarpal dorsal plaster splint, palmar finger splint and wire through the pulp of the finger

phalangeal joint is in about 15 degrees flexion and the inter-phalangeal joints in 30 degrees (Figs 129 and 130)

The fixation is finished off in exactly the same way as in fractures of the fingers, and movements of all the sound joints are started from the first day The fixation is removed at the end of four weeks and good movement is soon established

(*b*) Open reduction is indicated when orthopædic treatment has failed Each method has its own indications —

Wire binding in bevelled fractures

Osteosynthesis by plating or, better still, by wire suture in transverse fractures.

Transarticular nailing when the fracture is near the distal end after Lambotte's technique already described

Theoretically open reduction is very simple and easily performed on account of the accessibility and the compara

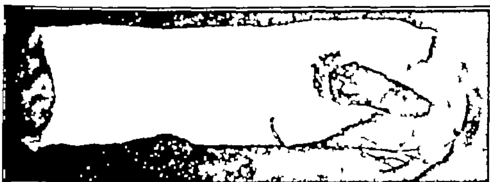


Fig 130 **Fracture of the second, third and fifth metacarpals** See X rays in Figs 131 and 132

Wires are passed through the pulp of the fingers which are then placed on finger splints, the latter are fixed to the dorsal splint with a plaster bandage The joints of the phalanges are not in sufficient flexion The plaster is not sufficiently trimmed at the level of the first metacarpal (after Bohler)

tively large size of the fragments In reality the risk of infection and intolerance to the metal are always to be feared and prudence always demands a preliminary trial of reduction by orthopædic means

BENNETT'S FRACTURE

It was the first articular fracture to be recognised and was first described by Bennett in 1881 to the Pathological Society of Dublin from a study of five pathological specimens

The line of fracture starts according to Bennett (6) from the middle third of the articular surface and runs distally along a frontal axis to end on the palmar surface at the junction of the proximal and middle thirds of the shaft it shows a slight curvature facing forwards Robinson has subsequently insisted on the possibility of a more or less greater obliquity of the line of fracture which extends to a more or less greater distance on the diaphysis

There are two fragments a large fragment consisting of the whole of the diaphysis and the posterior part of the articular surface and a small fragment which is more or less important and which represents the palmar articular projection of the

Fig 131 Fracture of the diaphysis of the fifth, third, and second metacarpals and of the base of the second metacarpal

The distal fragment of the second metacarpal is completely displaced inwards and backwards All show the typical angulation with the angle facing forwards

Fig 132 Control X-rays of the case shown in Fig 131 taken six weeks later

All the fractures are united in good position There is still some bone rarefaction Patient, man, aged 35, had full active movement of all his fingers at the end of twelve weeks

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Ætiology and Mechanism

The fracture is caused by two types of injury either a blow given or received on the radial border of the fist or a fall on the hand (according to Kuss (7) this is the commonest cause) which may be either open the palm of the hand striking the surface while the first metacarpal is in hyperabduction-extension or closed the first metacarpal being in the palm in the position of forced flexion and adduction

Under the action of this violence two mechanisms are capable of causing a fracture

Tearing in the hyperextended and abducted position the capsule does not give way and it is the palmar apophysis of the metacarpal that tears off One can thus explain only those fractures with small fragments by reason of the weakness of the palmar ligaments

Bursting by direct transmission accounts for nearly all the cases (Duroux Kuss) As is well shown by Gary it matters not whether the trauma is applied to the metacarpal in hyper abduction or in hyperadduction the end result is that the pressure is always and only transmitted to the overhanging apophysis which gives way and breaks off

Moreover careful consideration must be given to the architecture of the metacarpal. Maglulo and later Gary (8) and Siffre insist on the following point There are two systems of bone formation at the base an anterior one which is well developed and which includes the palmar apophysis and a posterior one which is thinner Between the two there is a lacunar space filled with areolar tissue and this is the weak spot and site of election for the break

Clinical Features

Pain is intense and incapacity is complete Considerable œdema occurs rapidly around the joint and later extends over the whole interosseous space When the swelling is still slight one is struck by a projection situated behind the trapezium this brings into relief the tendons of the anatomical snuffbox and gives the impression of a carpo metacarpal dislocation.

On palpation the deformity is confirmed and an antero posterior enlargement of the base of the metacarpal is noticed.

Two signs are essential the deformity which is easily reduced by traction in the axis of the thumb but which recurs

base The displacement of the fragments is as follows: the metacarpal goes upwards and outwards and is subluxated

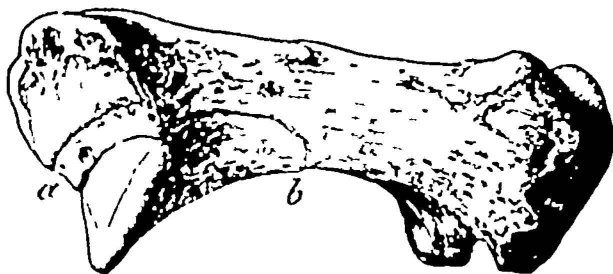


Fig 133 Bennett's fracture
Illustration taken from Bennett's original paper

on the trapezium It is, as a matter of fact, retained by the thick fibrous bands of the carpo-metacarpal joint, and that accounts for the rarity of a true dislocation of the trapezium-metacarpal joint It must be pointed out that, in its upward travel, this fragment approaches the radial artery where the latter runs over the trapezium, and that in the exposure of the fracture the artery may be wounded As to the small palmar fragment, it is very often not displaced, or else it is displaced forwards, rotated and pointing into the thenar eminence



Fig 134 Fracture-dislocation of Bennett (first metacarpal)

The small triangular fragment on the ulnar side has remained in place, while the base of the metacarpal is displaced outwards and upwards

In short, Bennett's fracture is an incomplete articular fracture, "entirely respecting the dorsal surface of the metacarpal, and detaching the greater part of the articular surface along with its supporting ledge of bone which projects into the palm" (Bennett) In the face of such an exact description, it is wrong to include with it other varieties of fractures of the base

It is necessary, therefore, to insist on the relative seriousness of Bennett s fracture in contrasting it with the benign nature of fractures of the bases of the other four metacarpals

Treatment

Bennett s fracture demands a treatment which is very special and difficult the technique of which, as advocated by Böhler is as follows —

An attempt at simple reduction followed by plaster immobilisation must be made first

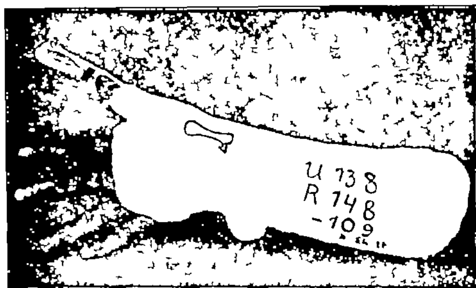


Fig. 125 Bennett s fracture-dislocation in completed cast

A plaster splint is laid on the extensor aspect from the knuckles to the elbow It also includes the first metacarpal and the base of the thumb A finger splint is applied to the radial side of the extended thumb and fastened with a plaster bandage A stainless steel wire is passed through the tip of the thumb and held by a wooden spreader It is fastened to the tip of the finger splint The fingers can be fully extended. The usual data are inscribed on the cast (after Böhler)

Reduction is carried out under local anæsthesia novocaine 2 per cent A rustless wire is passed through the pulp and its ends are passed through a small piece of wood measuring 2 cm by 1 cm The hand is placed in semi pronation and an assistant pulls with one hand on the four medial fingers and with the other on the thumb through the intermediary of a small stick tied to the wire The operator then presses on the site of fracture and reduces the subluxated metacarpal

The reduction is fixed as follows while the assistant main

immediately afterwards, sometimes with a characteristic crepitus The length of the metacarpal is not altered (Kuss)—a sign which is difficult to recognise clinically and which is easier to demonstrate by comparing radiographs of the two sides

Diagnosis

The picture is typical and can only be mistaken for a trapezium-metacarpal dislocation, which is a rare lesion In the latter the deformity is more marked, more regular and more difficult to reduce, but the reduction is permanent and occurs without crepitus

When displacement is slight or absent, the clinical diagnosis made is that of sprain It is then necessary to study very carefully the X-rays (antero-posterior and lateral views), in order *not to miss a fracture which is sometimes difficult to discover even on a film*

Prognosis

Bennett's fracture always has a serious prognosis When it is not properly reduced, there occurs rapidly and definitely a syndrome of old fracture, which has been well described by Imbert and Cottalorda

The thumb remains swollen and crooked All the joints are painful in their movements with limitation of opposition and mainly of adduction Grasping is impossible or difficult, it is clumsy and without strength A serious complication soon appears, the wasting of the first dorsal interosseous muscle, an atrophy, which may spread to the other muscles of the hand, and even to those of the forearm in serious cases The epiphysis feels larger than normal, and, by palpating from above downwards, one comes against a step-like projection which indicates the diaphyseal displacement The incapacity in these fractures is from 20 to 30 per cent , further, despite an early diagnosis and a correct reduction, it is very rare for Bennett's fracture not to leave its mark (swelling, pain and slight limitation of movement), all signs of a residual arthritis, the severity of which is in direct proportion to the incompleteness of the reduction The thumb remains useless and awkward, and it is not unusual to see these patients retain an incapacity of 5 to 10 per cent In certain cases, however, complete function has been restored (Kuss, Massini)

rather than with a Dujarier s clip (Cottalorda, J Giraud Petrignani)

After the operation it is wise to maintain the fracture in plaster as in the case of a recent one

After treatment The arm is placed on an abduction splint if there is much oedema

As soon as the plaster has set movements of the sound fingers of the forearm, of the elbow and shoulder are started

The splint is kept on for four weeks and another four to six weeks of active and passive movements massage hot air and diathermy are necessary for full function

End results

Union is perfect with a minimum or complete absence of incapacity in extra articular fractures The same does not apply to Bennett s fractures which are articular fractures with ligamentous injury and which are followed by chronic arthritis and muscular atrophy

In none of our patients did we see *restituo ad integrum* they all had a partial permanent incapacity amounting from 3 to 12 per cent

In cases of complex lesions of fractures united in bad position with deformity and corresponding uselessness of the thumb the incapacity may be as much as 20 per cent

Pseudarthrosis. Pseudarthrosis may occur in compound fractures

In his thesis Carcassonne (9) published a case following upon a crush Pseudarthrosis had been present for a year and the finger was practically useless A dorso-external incision exposed the site of fracture The ends of the fragments were denuded and freshened and co-apted by a Lane plate The wound was closed without drainage and the finger was immobilised in plaster in the position of abduction and opposition. A month after the operation the end result was perfect

The treatment of pseudarthrosis of the thumb by osteosynthesis is subject to the same criticisms directed against the treatment of pseudarthrosis generally By this method one is obliged to introduce foreign bodies that delay osteogenesis in a case in which osteogenesis is already poor An osteoperiosteal graft should be the method of choice provided that immobilisation of the fragments is complete in order to attain this it is necessary to include the forearm the metacarpals

tains traction, a plaster splint, extending from the elbow to the metacarpo-phalangeal joints, is placed on the dorsum of the forearm and hand Its distal extremity must be 20 cm in width It is cut between the thumb and the index finger and moulded round the metacarpal and the proximal phalanx of the thumb Traction is now exerted in slight abduction, and pressure is applied to the plaster on the posterior and lateral aspects of the base of the metacarpal A control X-ray is taken as soon as the plaster has set Two results are now possible —

(*a*) **The Displacement is Reduced.** The traction wire is removed and the simple plaster splint is left in place for four weeks, during which time active movements of the sound fingers are carried out in all directions

(*b*) **The Displacement Persists or Recurs.** Continuous traction must be maintained A finger splint is applied to the radial side of the thumb and fixed by a plaster bandage The wire is then tied to the end of the splint (Fig 135) The palm of the hand must be kept absolutely free The after-treatment is the same

Other Fractures of the Base and Diaphyseal Fractures

They are usually accompanied by angulation open medially, and they call for the same treatment as Bennett's fracture, *i e*, traction and immobilisation in abduction The position of the fracture in plaster is verified by X-rays, and altered, if necessary, by increasing or slackening the traction

Open Operation. In the recent fractures that we have just seen, operation is no longer indicated since the introduction of continuous traction, moreover, if the latter fails, the basal fragment is so small that there is not the slightest possibility of fixing it to the diaphyseal fragment

On the contrary, in old fractures (or rather, in those seen fifteen to twenty-one days after the injury, as is fairly frequent) the deformity has become irreducible and the patient, who is greatly incapacitated, asks for relief

Operation is then advisable The mode of access is either dorsal or dorso-external, the site of fracture is exposed and the fragments are disengaged if possible, or an osteotomy is performed if the callus is already too hard In any case, the two fragments must be co-apted and fixed, and this is best done with a bronze wire or silkworm gut passed through the bone

PART FOUR

ASSESSMENT OF INCAPACITY

As a rule the doctor who treats the patient does not have to assess the partial permanent incapacity that results from a wound The law of 1898 reserves him the right to indicate the date of cure (i e the date when treatment and half pay stop) and the existence of a partial permanent incapacity but without assessing the latter He is however always obliged to accede to the request of a patient who wants to know the approximate degree of his incapacity and if his estimate is false there may ensue many difficulties and resentment on the part of the patient who will consider that his most sacred rights have been encroached upon

This is why while drawing inspiration from the remarkable work of L Mayet (1) we have reproduced some of the assess ments of this author But they are only probable average figures and for further details it is absolutely necessary to consult the book itself which is indispensable to anyone looking after works accidents

AMPUTATIONS

	Right hand %	*Left hand* %
Complete loss of the right hand	65	52
Loss of use of the right hand :		
(a) Due to complete loss of all the fingers (hand reduced to a metacarpal stump) and the wrist ankylosed	65	52
(b) *Id* with movable wrist	6_	51
(c) Due to immobilisation in extension of all the fingers, irrespective of the state of of the wrist	65	50
(d) Due to immobilisation in flexion of all the fingers (ankylosis, contractures)	60	50
Partial loss of the right hand.		
The right hand has three anatomical and physiological segments, whose working value is assessed at :		
1 Thumb and its metacarpal	28–30	22–24
2 Index and medius	30–35	24–28
3 Annularis and auricularis	14–18	12–15

and the thumb in the plaster cast, which is very carefully moulded to the thumb at the level of the fracture, and to maintain continuous traction

These operations are rarely indicated, but it is useful to know them, for in the few cases where they can be utilised they bring about a cure to a patient who would otherwise be definitely incapacitated

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Loss of segments of the fingers.	*Right hand.* %	*Left hand.* %
I. *Thumb*		
Partial loss (about half) of the terminal phalanx	3 5	2–4
Complete loss of the terminal phalanx	12	10
Loss of two phalanges	25	18–20
Loss of two phalanges and half of the metacarpal the remaining segment being mobile	27	2[illegible]
Complete loss of the thumb (the two phalanges and the metacarpal)	30	24
II *Index*		
Partial loss of the terminal phalanx	1–2	1–2
Complete loss of the terminal phalanx	5	3–4
Loss of one and a half phalanges the remaining stump mobile	8	6
Loss of two distal phalanges	10	7–8
Loss of two and a half phalanges, remaining stump mobile	13	11
Loss of three phalanges	15	10–12
III *Medius*		
Partial loss of the terminal phalanx (about half)	0–1	0–1
Complete loss of the terminal phalanx	2–3	2–3
Loss of one and a half phalanges the remaining stump mobile	5	4
Loss of two distal phalanges	7	6–7
Loss of two and a half phalanges, the remaining stump mobile	8	7–8
Loss of three phalanges	1[illegible]	8–10
IV *Annularis*		
Partial loss of the terminal phalanx	0–¼–1	0
Total loss of the terminal phalanx	1–2	1–2
Loss of one and a half phalanges, remaining stump mobile	4	3
Loss of two phalanges	5	4
Loss of three phalanges	8	6 5
V *Auricularis*		
Partial loss of the terminal phalanx	1	¼
Total loss of the terminal phalanx	2	1
Loss of two phalanges	6	4–5
Loss of three phalanges	8	7

ANKYLOSIS

Ankylosis of the right hand.		
(*a*) Ankylosis of the wrist (complete absence of flexion and extension) and loss of pronation and supparation, the fingers being mobile	35	Assessments based on those of the right hand *less one fifth.*
(*b*) Ankylosis of the joints of the hand and of all the fingers	60	
Ankylosis of four fingers, the thumb being mobile	45–48	

Ankylosis of segments of the fingers.	
I. *Thumb*	
Articulation II (in complete extension)	8
Articulation II (in complete flexion)	10

The loss of each finger, considered separately, is assessed at :	*Right hand* %	*Left hand* %
1 Thumb with its metacarpal	30	22–24
Thumb only	25	20
2 Index, finger for delicate touch and pointing	15	10–12
3 Medius, the strong finger	12	8–10
4 Annularis	8	6 5
5 Auricularis	8	7
Loss of two fingers.		
I Thumb (with its metacarpal) and index	42–44	37
Thumb (two phalanges) and index	40	32
Thumb and medius	38	28–32
Thumb and annularis	35	26–27
Thumb and auricularis	35–36	28
II Thumb intact and index amputated		
Index and medius	30–35	26–28
Index and annularis	20–24	20
Index and auricularis	22–25	20–22
III Thumb and index intact, medius amputated		
Medius and annularis	23	18
Medius and auricularis	20–22	18–22
IV Thumb, index and medius intact, annularis amputated		
Annularis and auricularis	16–18	15
Loss of three fingers		
I Thumb, index and medius	48–50	44
Thumb, index and annularis	43–45	36
Thumb, index and auricularis	44–46	36
Thumb, medius and annularis	44	36
Thumb, medius and auricularis	43–44	37
Thumb, annularis and auricularis	40–43	35
II Thumb intact, index, medius and annularis amputated	40–45	38
Thumb intact index, medius and auricularis amputated	38–42	35
Thumb intact, index, annularis and auricularis amputated	30–33	28–30
III Thumb and index intact, medius, annularis and auricularis amputated	28–32	27–30
Loss of four fingers		
Including the thumb (with its metacarpal)	60	50
Including the thumb (without its metacarpal)	58	45
Excluding the thumb, but stiff	58	50–52
Excluding a mobile thumb	55	42
Loss of five fingers		
Equivalent to complete loss of the hand	60–65	52
Complete loss of function of the five fingers		
Equivalent to complete loss of function of the hand	58–60	48–50
Nearly complete loss of function of the five fingers		
Slight degree of opposition present	55	46–47

	Right hand %	*Left hand* %
A *Auricularis*		Assessments based on those of the right hand *less one fifth*
Articulation III	0–1	
Articulation II	3	
Articulation I	4	
Articulations III and II	5	
Articulations III II and I in extension	7	
Articulations III II and I in partial flexion	5	
Articulations III II and I in complete flexion	8	

STIFFNESS OF THE JOINTS

Complete loss of function of the right hand		
Equivalent to complete loss of use of the right hand		
(*a*) Due to immobilisation of all the fingers in extension, whether the wrist is mobile or not	60	50
(*b*) Due to immobilisation of all the fingers in flexion	58	48

CUT TENDONS

Complete section of the extensor tendon		
Immediately proximal to its insertion in the terminal phalanx, the latter remaining in permanent flexion.		
Thumb (extensor pollicis longus)	6	Same scale *less one-fifth.*
Index	2	
Medius	1	
Annularis	0–1	
Auricularis	½–1	
Immediately proximal to the second phalanx, the II and III phalanges remaining in permanent flexion.		
Index	5	
Medius	4	
Annularis	3	
Auricularis	3	
At the base of the finger with loss of action of the lumbricals and interossei and long extensors (finger in permanent flexion)		
Thumb (extensor pollicis brevis)	12	
Index (extensor indicis proprius and extensor digitorum communis)	12	Same scale as for the right hand *less one fifth.*
Medius	10	
Annularis	7	
Auricularis (extensor minimi digiti quinti)	8	
Complete section of the flexor tendons		
Proximal to interphalangeal joint II (the terminal phalanx remaining in permanent extension and there is dynamic deficiency of coiling up of the finger)		
Thumb (flexor pollicis longus)	8	
Index (flexor digitorum profundus)	3	
Medius (flexor digitorum profundus)	2	
Annularis (flexor digitorum profundus)	½–1	
Auricularis (flexor digitorum profundus)	1	

	Right Hand. %	*Left Hand* %
Articulation I (in semiflexion)	8	Assessments based on those of the right hand *less one fifth*
Articulation I (in extension or in complete flexion)	10	
Articulation trapezium metacarpal	15	
The two distal joints		
Thumb in slight flexion	15	
Thumb in extension	18	
Sprain of the thumb (metacarpo phalangeal joint), sequelæ of sprains of the thumb with arthritis, laxity of the joint or, on the contrary, more or less marked stiffness, trophic phenomena		
(*a*) If the stiffness is in flexion	4	
(*b*) If the stiffness is in extension	8	
Dislocations of the thumb, non reducible or unreduced The principal causes of partial permanent incapacity are Z shaped deformity of the thumb, impotence of the finger, functional impediment of the hand is sometimes equal to a sixth, a fifth, or sometimes a fourth of the working value of this		
Dislocation of the terminal phalanx .	4–5	
Dislocation of the metacarpo-phalangeal joint	10–15	
Snapping thumb (interphalangeal joint)	2–3	
Imputability is often very debatable		
Necessity of establishing that an injury took place and that the condition was absent before the alleged injury		
Forced adduction of the thumb which remains "stuck" to the index by a scar and mainly by suppression of the action of the abductor pollicis longus, depending on the degree of flexion retained	20–25	
II *Index*		
Articulation III in forced flexion	1–2	
Articulation II	6	
Articulation I	8	
Articulations III and II in extension	9	
Articulations III, II and I in extension	15	
Articulations III, II and I in incomplete flexion	12	
Articulations III, II and I "en griffe," the nail touching the palm	15	
III *Medius*		
Articulation III in flexion	2	
Articulation II	7	
Articulation I	6	
Articulations III and II	8	
Articulations III II and I either in extension or in flexion	10	
IV *Annularis*		
Articulation III	0–1	
Articulation II (in flexion)	5	
Articulation I	5	
Articulations III and II	6	
Articulations III, II and I in extension or in complete flexion	7	
Articulations III, II and I in partial flexion	4	

INDEX

	Right hand %	*Left hand* %
At the level of, or proximal to, the metacarpo-phalangeal joint (as a unit, the finger stays in permanent extension, except sometimes flexion of the proximal phalanx on account of the action of the short muscles)		Same scale as for the right hand *less one fifth*
Thumb (flexor pollicis longus) .	20	
Index	12	
Medius	10	
Annularis .	7	
Auricularis	8	

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